THURSDAY, JUNE 20, 1901.

CHARLES ST. JOHN.

Charles St. John's Note Books, 1846—1853, *Invererne, Nairn, Elgin.* Edited by Admiral H. C. St. John. Pp. 119. (Edinburgh: D. Douglas, 1901.) Price 7*s.* 6*d.* net.

TO many an elderly man, among whose most cherished possessions in bygone days was a well-thumbed copy of "Wild Sports in the Highlands" and who now from "life's passionless stage" looks fondly back on the imaginations of youth, "St. John" is still a magic name, awakening, like Campbell's wild flowers, forgotten affections. It brings with it a whiff of the smell of fresh trout frizzling in the mountain sheiling, blue with peat smoke, and calls up visions of misty moors and tumbling rivers, of "muckle harts," wild cats and martens, and

"Sweet little islands twice seen in their lakes,"

gardens of the Hesperides of boyish dreams.

The sportsman-naturalist was a great-great-nephew of the namesake to whom Pope dedicated his "Essay on Man," the first Lord Bolingbroke, and began life as a clerk in the Treasury. A single legend only relating to him survives in Whitehall. A warrant of some importance was wanted, and St. John's chief, remembering that not long before it had been given to him to copy, asked him for it.

The warrant was not forthcoming, and St. John, pressed to find it, with a slight stutter, not impossibly increased by a little nervousness, apologised: "I put it into the fire because it b-b-bored me."

The story may be mythical. But as, according to his own account, he "gave notice to quit to prevent a reversal of the process," it is perhaps not uncharitable to assume that he was one of His Majesty's indifferent bargains.

On leaving the Treasury he retired to a shooting property in the north of Scotland, lent him by a cousin, and shortly afterwards married a Scotch lady blessed with enough of this world's goods to enable him to enjoy to the full a life of busy idleness among red deer and salmon.

It was to a chance acquaintance with Mr. Cosmo Innes, then Sheriff of Moray, and an occasional contributor to the *Quarterly Review*, that three generations of boys are mainly indebted for "Natural History and Sport in Moray" and the yet more fascinating "Wild Sports," which has run through at least seven editions. Mr. Innes was spending an autumn holiday on a property adjoining the shooting over which St. John was privileged to wander with rod and gun. He had wounded a brace of partridges and had followed them from the island in the Findhorn where he found them to a turnip field on the opposite bank, and was looking for them when "a tall, gentlemanly man" with a poodle "with a Mephistopheles face," got over the fence and offered to find the birds which he had marked down.

Mr. Innes called in his pointers and the poodle, "with a series of curious jumps on all fours and pauses between to listen," made short work of the birds—and with this introduction a close friendship sprang up between the two men.

It was a few years later, when a day's cover shooting had been spoilt by a Highland downpour, and St. John, wrapped in a coat of sealskin of his own killing, had whiled away a long wet drive home with stories of sport and of the ways of birds and beasts he had watched, that Mr. Innes first suggested the idea that he should publish his experiences.

St. John was modest, and at first scouted the notion that he could write anything worth printing, but he mentioned "some old journals" which might, if ever the attempt were made, be useful.

The book named above contains these journals, which are now published for the first time in the form in which they were originally written, by the writer's son, Admiral St. John.

The cream of the notes was skimmed long ago for the two books which established St. John's fame, and though well worth printing, their chief interest, for those at least who are familiar with them, now lies, perhaps, in the light thrown on the secret of the fascination which—in spite of the amiable egotism which is apt at times to jar a little—those books possess.

Like White of Selborne and, on a broader canvas, Shakespeare, St. John drew direct from nature.

From a hundred pages, in almost every one of which are texts from which a naturalist might preach a sermon, it is not easy to make selections. But one or two little touches, taken almost at random, are enough to illustrate the breezy freshness of his notes.

"The tracks (of otters) which we see," he writes, "are almost invariably going up the river, showing that the animal keeps the course of the stream in her downward course; but, on coming up, frequently leaves the water to go a few yards along the bank."

Fine swimmer as she is the otter is not a salmon, above all such considerations as up stream and down stream. Again, at the same opening (p. 82),

"The bill of the oyster catcher (unlike the highly sensitive bills of ducks, woodcock and curlews, which patter or bore in the mud for small worms, &c., described a few lines earlier) is as hard as ivory at the tip, the bird using it more for breaking open shell-fish than for digging in the mud."

To give only two more quotations (pp. 74 and 86),

"Wild cats are brindled grey, and I have observed that domestic cats of that colour are more inclined to take to the woods and hunt for themselves than others."

"It blew a hurricane to-day from the W.N.W., with cold showers. . . . I saw a seagull caught by the wind in the air and turned over five or six times before it could recover its balance and get its head to windward."

Admiral St. John, before publishing his father's notes, visited again the scenes of his childhood, and has recorded his impressions in a short preface, "Moray Revisited."

Here, too, as everywhere else in the book, is food for thought for a naturalist.

Stone walls had given place to wire fences; but just where six and thirty years before, in 1851, he had found the nest of a "shoveller," a bird "not common in the locality," a shoveller with a brood of five "swam out of the tall rushes into the open water" as he walked down the river. What is the secret of the lasting attraction of certain particular spots for certain birds? The little brown-headed gulls crowd their nests, very inconveniently close together

as it seems to ignorant human beings, in hundreds at one small corner only of a roomy island in Scoulton Mere, and Sheerwaters collect to breed in one only of the hundred and fifty islands of the Scilly archipelago. Guillemots, identified by peculiar egg markings, lay year after year, as Yorkshire cliff climbers agree, "within half an inch" of the same spot on the same narrow ledge.

"Water ouzels," writes St. John (p. 55), "come to the burns near the sea about the beginning of October. The same stones are occupied year after year by these birds."

In a Norfolk cover well known to the present writer, if there was a woodcock in the neighbourhood one was almost always to be found under one particular laurel bush.

Surroundings may completely change without breaking the charm. Thickknees love open spaces, and as a rule nest nowhere else. But Prof. Newton, in the article on migration in his "Dictionary of Birds," tells of their eggs laid in a thick Suffolk cover, in the precise spot where years before, when the ground was still an unplanted heath, birds of the species had been accustomed to breed.

The only thing to be objected to in an otherwise altogether charming book is the paper on which it is printed, which is abominable.

The dazzling glaze which makes reading by candlelight a pain instead of a pleasure is too high a price to pay even for St. John's spirited and witty pen and ink sketches.

If the use of the highly pressed and metallically polished papers which, since the invention of "process blocks," have become fashionable in illustrated magazines is carried much farther—the danger is very real and serious—the eyes of the rising generation will fail them long before their time.

There is something pathetic in the thought of the number of men, younger sons of country gentlemen and sons of officers, clergymen and professional men, born with the deepest-seated of aboriginal instincts—the love of sport—ingrained in their natures and brought up among birds' nests and sticklebacks, who find themselves, during the best years of their life, cut off from all that is most congenial to them and their manhood slipping from them in the close atmosphere of towns.

A writer who, like Charles St. John, can while them away from cramping surroundings and keep alive for a little longer the ever-receding dream of the good time to come some day, is not a man who has lived in vain.

T. DIGBY PIGOTT.

EXERCISES IN HYGIENE.

The Science of Hygiene: a Text-book of Laboratory Practice. By Walter C. C. Pakes, D.Ph. (Camb.), F.C.S. Pp. xv + 380. (London: Methuen and Co., 1900.)

"HITHERTO there has appeared no single text-book dealing with all the practical laboratory work which is now required from the candidate for the Diploma in Public Health." So the author writes in his preface, and the work under review is the result of his attempt to remedy what he considers to be "a great disadvantage."

When it is pointed out that in this manual some five subjects are dealt with, each of which has furnished the subject-matter of well-known text-books of similar bulk to the present volume, it is evident that Mr. Pakes's effort must partake somewhat of the nature of a cram book.

"The Science of Hygiene," we would point out, is far too pretentious a title for a small manual which at the most affords the student an incomplete digest of a very extensive branch of study. The inadequacy of treatment would be sufficiently apparent if the different kinds of subject-matter were dealt with in good proportion, but this is not so, for we find the difficult subject of vital statistics disposed of in nineteen pages, ten of which are devoted to the construction of a life table, with the result that no mention is made of one of the most important matters dealt with in vital statistics, namely, the rate of infantile mortality; the subject of physics is dismissed without any mention being made of the siphon or of the common pump, the principles of which should certainly be understood by the public health student; and the great and important matter of the chemical examination of food is dealt with in twenty-eight pages. On the other hand, the part of the work dealing with microscopy covers eighty-nine pages and is by far the most complete and best part of the book.

The work is divided into five parts. Part 1 gives an outline of bacteriology; the brief directions here given are generally sufficient if the worker has the advantage of a teacher at hand when he attempts to put them into practice, otherwise he will frequently find them insufficient. Part 2 deals with microscopy; the illustrations are for the most part good, but the representations of the starches are crude and unsatisfactory. No drawing is given of Cyclops or of Gammarus Pulex, two organisms of far more common occurrence than several of those dealt with by the writer.

In mounting the starches for microscopical examination the student is told to use a "sterilised loop" to moisten the starch with, and a further instance of carelessness is the fact that pages illustrating water sediments are headed "Internal Parasites."

Part 3, which deals with chemistry, also contains blemishes. With reference to the physical characters of water it is said that "if there is any yellowish or brownish colour there will be some suspicion of sewage contamination, unless the water happens to have been collected from a peaty soil." We should have been more disposed to warn the student that it is very rare indeed for sewage contamination, even when it is very considerable, to colour water; iron, on the other hand, is one of the more common causes of such coloration.

In the estimation of chlorides the red precipitate of chromate of silver is described as "brown." The method described for the "estimation of calcium" will include magnesium; and the "estimation of magnesium," when performed in accordance with the directions given, will lead to a very serious under-estimation.

Although the author does not offer "more than a few hints to enable those who are not adepts to avoid the many pitfalls which await them," his remarks upon the interpretation of the results of the analyses of water are faulty in places and would not be acceptable to those

who are most *au courant* with this subject. There are many indefinite statements such as the following: "it may happen that a particular geological stratum contains a considerable excess of chlorine," "some geological strata contain nitrates to some considerable degree," "speaking as a rule to which there are of course notable exceptions, drinking water ought not to contain more than 0·5 part per 100,000 of nitric nitrogen."

It is said that a good deep well water often does not absorb more oxygen from the permanganate solution (in four hours at 27° C.) than 0·001 grm. per 100,000. Surely such deep well waters must be very exceptional.

A sample of upland surface water is given with 0·07 of free ammonia, 0·2 of albuminoid ammonia and 0·12 of oxygen absorbed, and with total solids amounting to 2·8 in parts per 100,000, and one of subsoil water with free ammonia 0·12, albuminoid ammonia 0·033, and oxygen absorbed 0·52, without any indication of the fact that these waters are grossly polluted.

Part 3 also deals with the analyses of sewage, sewage effluents and food. In examining sewage, the student is advised that it often happens when 10 or 20 c.c. of sewage are added to 500 c.c. of ammonia free water, that twelve or fourteen Nessler glasses of distillate are collected before the yield of albuminoid ammonia ceases. This is surely a singular experience. Working at such dilutions and under the directions given by the author, it would be extremely rare that more than five or six Nessler glasses would be required; moreover, fourteen Nessler glasses would hold 700 cubic centimetres of distillate, and how is the student to collect this from only some 500 cubic centimetres of liquid in the boiling flask?

On the subject of food analysis we are informed that analysts of repute obtain the specific gravity of milk by weighing with the specific gravity bottle. If this is so, surely there must be few analysts of repute in this country. The average amount of water in butter is put at 8·55 per cent., which is too low; and it is stated that no butter should be condemned as adulterated with water unless it contains less than 80 per cent. of fat; whereas the limit of water accepted by the Society of Public Analysts is 16 per cent. It is said that "in a normal sample of bread there is as much alum as silica," and that "the weight of silica found must therefore be deducted from the amount of alum found, and any excess will represent added alum." As a matter of fact alum is never found in pure bread, nor is it correct to state that there is as much alumina as silica in normal bread.

That the alcohol of wine and beer is determined exactly as in the case of spirits is a bald statement the insufficiency of which will be manifest to the student when, for instance, he first essays an estimation of the alcohol in beer. Doubtless by a printer's error "the Sinaitic Peninsular" is referred to on p. 152, while the atomic weight of silver is given as 107·7 on p. 191, and as 108·0 in the appendix.

It must be said, then, that the volume is on the whole an unsatisfactory one, in which most of the subjects are dealt with, not only inadequately, but sometimes faultily, owing to the attempt to compress too much matter into too small a space.

The subjects of bacteriology, public health, chemical work, physics and vital statistics have, as a matter of fact, all been dealt with in practical manuals in such a manner that the serious student will not find much use for the book under review.

PUBLIC WATER-SUPPLIES.

Public Water-Supplies: Requirements, Resources, and the Construction of Works. By F. E. Turneaure, C.E., and H. L. Russell, Ph.D. Pp. xiv+746. (New York: John Wiley and Sons, 1901. London: Chapman and Hall, Ltd.)

WATER-SUPPLY is unquestionably one of the most important branches of civil engineering in the present day, owing to the widespread nature of the demands for it, the great value attached to a pure supply, resulting from the progress of sanitary science, and the increasing difficulty, in populous countries, of obtaining an unpolluted and adequate supply. This book has been prepared with the object of supplying the needs of teachers and students in technical schools; and the greater portion of it is based on the experience of the first-named author in teaching the subject for many years, which forms one branch of his courses of lectures in the University of Wisconsin. A novel feature in this volume is the conjunction of an engineer and a chemist in its production, thereby enabling the engineering and bacteriological aspects of the question to be dealt with respectively by very competent experts; whilst a chapter on pumping machinery is contributed by another engineer. Fundamental principles have been given more prominence than details of construction, though these latter have been largely made use of to illustrate the principles involved and differences in the conditions, and a considerable space has been devoted to the quality and purification of water-supplies, constituting such important considerations from a sanitary point of view, and also to the questions connected with ground-water. The comprehensive scope of the book, and its exhaustive, though concise, treatment of the subject are most effectively illustrated by a reference to the headings of the twenty-nine chapters into which the book is divided.

The subject is opened by an introductory chapter giving a very brief historical sketch, from the earliest times, of the development of water-supplies, and a statement of the value and importance of a public water-supply for domestic, commercial and public uses. The book is then divided into two parts, the first dealing with "Requirements and Resources," and the second with "The Construction of Water-Works," in nine and nineteen chapters respectively. The first part is subdivided into two sections, with the respective headings, "Quantity of Water Required: Sources of Supply," and "Quality of Water-Supplies," occupying six and three chapters respectively. The first section comprises the quantity of water required, sources of supply, rainfall, evaporation and percolation, flow of streams, and ground-water; whilst the second section deals with the examination of water-supplies, the quality of water, and communicable diseases and water-supplies. The second part of the book, which is devoted to construction, after two introductory chapters dealing with generalities pertaining

water-works construction and hydraulics, is subdivided into three sections, treating successively of works for the collection, purification and distribution of water, in six, five and six chapters respectively. The works for the collection of water comprise river and canal intakes, the collection of ground-water, impounding reservoirs, earthen dams, masonry dams, and timber, steel, and loose-rock dams; the section relating to works for the purification of water includes the objects and methods of purification, sedimentation, sand filtration, mechanical filtration and miscellaneous purification processes; and the section dealing with the distribution of water describes systems of pipes for conveying water, conduits and pipe-lines, pumping machinery, distributing and equalising reservoirs, the distributing system and operation and maintenance.

From this summary of the contents it will be seen that all the principal problems and works relating to water-supplies are duly considered in succession; whilst in several chapters the careful classification of the subjects is carried a step further, by the consideration of different branches of the subject to which the chapter is devoted, under separate headings; and the purport of every main paragraph is clearly indicated by a black-letter heading. Moreover, the descriptions are illustrated by two hundred and thirty-one figures in the text; and the quest for further information is greatly facilitated by a list at the end of each chapter of the principal publications on the special subject treated of in the chapter. Naturally, on such a subject as masonry dams, for instance, more particulars might be desired than can be compressed into twenty-two pages, especially as a considerable portion of this limited space is occupied by cross sections of notable dams; and in this case the list at the end of the chapter contains fifty-two references to books, pamphlets, and periodicals describing masonry dams, and six references in addition to failures of these dams; whilst at the end of the chapter on earthen dams there are twenty-seven references to descriptions of such dams, and eleven to their failures. The book, indeed, dwells rather upon general principles and problems than on descriptions of works, except in smaller print by way of illustration, and reliance is placed mainly on the consultation of the publications given in the list for information about details of works. A sound groundwork is presented to the student in a concise form, with reference to the considerations affecting the sources and quality of water, and the nature of the works carried out for the collection, purification, and distribution of water-supplies; and it is expected that he will add to his knowledge thus acquired by the aid of the authorities indicated, and the teachings of experience. This volume, moreover, though specially valuable to students, should also prove useful to experienced engineers, owing to the excellent classification of subjects, the amount of information collected within its pages, and the lists of publications on the various subjects; and whilst engineers will derive special benefit from the full chemical consideration of the quality of water, the diseases transmissible by it, and its purification, chemists interested in water-supplies may gain some advantage from the clear and concise explanations given of the engineering problems and works relating to water-supply.

OUR BOOK SHELF.

Leitfaden der Wetterkunde. Gemeinverständlich bearbeitet. Von Dr. R. Börnstein, Professor an der Königl. landwirthschaftlichen Hochschule zu Berlin. Pp. viii + 181. (Braunschweig: Vieweg und Sohn, 1901.)

IT is one of the peculiarities of foreign countries that they have professors of meteorology in their universities and departmental colleges, and the book before us reminds us of that fact. It is a professor's book. It gives a survey of the present state of knowledge of the subject in a form suitable for presentation to a class of intelligent and educated students. The arrangement of the text is systematic and methodical, not historical. It begins with the composition of the atmosphere, and then deals with the elements of climate, namely, temperature, moisture, cloud and precipitation. Then it passes on to consider pressure and its relation to wind and weather, and concludes with an account of the weather services of different countries. It is "gemeinverständlich" in the sense that the special application of mathematics to meteorology is not treated in detail. Instruments are referred to and described, but the details of the process of observation and instructions for observers are not considered.

Within the limits indicated the work is quite successful. The most recent developments of the science are appropriately referred to. The portions dealing with thunderstorms and with weather types are especially satisfactory sections, and all the different parts are effective and concise. The more experienced students of the subject will find the references to original sources of information collected together at the end of the book especially useful. They form a short but comprehensive bibliography of the most important recent work on meteorology. They follow the arrangement of the text, but the excellent alphabetical index to the book makes it easy to look out a reference either to a subject or an author. One misses from the index the names of some prominent American meteorologists, and there are several departments of the science which are only lightly treated; but, as already stated, the book is a professor's presentation of the subject, and is not intended to be exhaustive.

The classification of clouds is the international one, under which clouds of certain types are assigned to certain limits of height. The nine plates of cloud forms are excellent reproductions from the International Cloud Atlas. In other respects also the book is well illustrated, and the print and binding are good.

Myths of Greece explained and dated. An Embalmed History from Uranus to Perseus, including the Eleusinian Mysteries and the Olympic Games. By George St. Clair. 2 vols. Pp. 796. (London: Williams and Norgate, 1901.) Price 16s.

WE do not understand what Mr. St. Clair means by an "embalmed history," and we do not think that the work which he calls by this strange title will be of the least use either to archæologists or ethnologists. Mr. St. Clair starts with the preconceived notion that all myths are of astronomical origin, and argues on the basis of this preconception, *e.g.*, p. 38, "The voyage of the Argonauts was an astronomic quest, as we must surely recognise as soon as we learn that the golden fleece which they sought belonged to the Ram of the Zodiac" (!) The rest of the book is mostly in this strain. The author cannot prove Hera, Leto, Artemis, Hades, Hephaistos or Dionysos to be astronomical, so calmly says (p. 37) "The shifting of pole and equinox and the sponging-out of constellations—which may have been required by calendar-reforms—have made the mythology to appear less astronomical than it was. . . . Most likely many of the Greek divinities may still be found in the sky, under some alias or disguise." And so forth.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Does Chemical Transformation Influence Weight?

CAREFUL experiments by Heydweiller, published in the last number of Drude's *Annalen* (vol. v. p. 394), lead their author to the conclusion that in certain cases chemical action is accompanied by a minute, but real, alteration of weight. The chemical actions here involved must be regarded as very mild ones, *e.g.* the mere dissolution of cupric sulphate in water, or the substitution of iron for copper in that salt.

The evidence for the reality of these changes, which amount to 0·2 or 0·3 mg., and are accordingly well within the powers of a good balance to demonstrate, will need careful scrutiny; but it may not be premature to consider what is involved in the acceptance of it. The first question which arises is—does the *mass* change as well as the *weight*? The affirmative answer, although perhaps not absolutely inconsistent with any well ascertained fact, will certainly be admitted with reluctance. The alternative—that mass and weight are not always in proportion—involves the conclusion, in contradiction to Newton, that the length of the seconds' pendulum at a given place depends upon the material of which the bob is composed. Newton's experiment was repeated by Bessel, who tried a number of metals, including gold, silver, lead, iron, zinc, as well as marble and quartz, and whose conclusion was that the length of the seconds' pendulum formed of these materials did not vary by one part in 60,000. At the present day it might be possible to improve even upon Bessel, or at any rate to include more diverse substances in the comparisons; but in any case the accuracy obtainable would fall much short of that realised in weighings.

As regards Heydweiller's experiments themselves, there is one suggestion which I may make as to a possible source of error. Is the chemical action sufficiently in abeyance at the time of the first weighing? If there is copper sulphate in one branch of an inverted U and water in the other, the equilibrium can hardly be complete. The water all the time tends to distil over into the salt, and any such distillation must be attended by thermal effects which would interfere with the accuracy of the weighing. RAYLEIGH.

June 11.

The National Antarctic Expedition.

IN consequence of a cable received yesterday from London, telling me that the instructions for the conduct of the National Antarctic Expedition that had been passed by the Joint Committee of the Royal Society and the Royal Geographical Society have been greatly altered, I feel it my duty to resign the post of head of the civilian scientific staff of the expedition, which I had provisionally accepted. The organisation of the expedition now passed leaves the head of the civilian scientific staff nominally responsible for most of the scientific work of the expedition, but gives him no power to secure the performance of the scientific part of the programme.

The responsibility for my withdrawal at so late a date rests with those who have delayed until now the settlement of the programme and organisation of the expedition, which should both have been decided, as I understood they had been, before the ship and most of the equipment had been ordered.

I trust the protest of my withdrawal will secure to my successor more favourable conditions of work than the altered instructions would have given me.

University, Melbourne, May 4. J. W. GREGORY.

The Settlement of Solid Matter in Fresh and Salt Water.

SINCE the publication of the report of Mr. Slidell[1] on the deposits of the Mississippi delta, containing the remarkable statement that while the deposit contained in the river water of the Mississippi took from ten to fourteen days to settle, with solutions of salt, sea water or sulphuric acid the water became limpid in from fourteen to eighteen hours, it has generally been taken as an accepted fact that alluvial matter settles more rapidly in salt than in fresh water. Sir Archibald Geikie, in his "Text-book of Geology," endorses this theory; and in a recent article in the *American Engineering Magazine* on the transportation of solid matter by rivers, Mr. Starling, one of the Government river engineers, states that a small quantity of salt or other foreign material dissolved in water will diminish the suspending power and increase the rapidity of subsidence to a marked degree, sometimes even many hundred-fold.

On the face of it the result naturally expected would be, that as sea water is of greater specific gravity than fresh water, and more viscous, the grains of solid matter would sink more slowly in salt than in fresh water. The very great distance over which solid matter brought down by rivers remains in suspension after reaching the sea, extending from six miles from the mouth of the Rhone to thirty-five from the outlet of the Nile, up to 300 miles over which the sea water is stated to be discoloured by the effluent of the Amazon, appears to indicate that salt water is capable of retaining solid matter in suspension for a longer time than fresh water.

Experiments made by Mr. Vernon Harcourt with alluvial matter placed in suspension in sea water and fresh water, and in solutions containing different strengths of salt and other foreign material, although not of a conclusive character, show that there is little difference between the rate of deposit in sea or in fresh water. Of samples from different estuaries which were allowed to settle in sea water and pond water respectively, the particles of the former took about 9 per cent. more time to subside than the latter. The general conclusion he arrived at was that, though sea water promotes the deposit of "very light clayey matter contained in river silt under favourable conditions, there are no grounds for regarding it as exercising the very preponderating influence on the formation of deltas attributed to it by geologists."[1]

The writer some time ago investigated this subject in connection with researches he was then making as to alluvial deposits in estuaries, and has again more recently conducted a series of experiments the mean results of which are given in the following table:—

Table Showing Rate of Settlement of Solid Matter in Fresh and Salt Water.

No.	Number of grains to a lineal inch	Material	Time taken to settle		Water clear		
			Fresh	Salt	Fresh	Salt	
			m. s.	m. s.	h. m.	h. m.	
1	100	Sand	0 10	—	—	—	Water not discoloured
2	200	do.	0 25	—	—	—	do.
3	—	Whiting ...	12 0	—	0 30	—	
4	—	Plaster of Pari-	5 0	—	0 10	—	
5	300	Warp, Trent	0 43	0 45	0 1	0 1	Water scarcely discoloured
6	1400	Fine Warp, Dutch River	12 0	15 0	3 30	22 0	
7	500	Silt, Salt Marsh	2 0	2 0	0 6	0 9	
8	1000	Warp, do. ...	8 0	9 0	1 0	0 33	
9	2000	Alluvium, Boston Dock ...	33 0	28 0	7 0	1 30	
10	600	do., R. Parrett	4 0	2 40	0 15	0 18	
11	1500	do., Tilbury Bsn.	18 0	18 0	10 0	9 0	
12	1600	Brick Clay ...	17 0	15 0	1 30	1 9	

It will be seen from this table that the rate of deposit depends on the minuteness of the particles in suspension, and varies nearly in proportion as the square of the diameter of these.

With sand and silt there was practically no difference in the rate of settlement in fresh as compared with salt water. When the particles of the solid matter were very fine, as in the case of what is generally known as mud or ooze, the rate of settlement was slightly more rapid in salt than in fresh water; but there was nothing to justify the conclusion arrived at by Mr. Slidell.

All the material was first screened through a sieve having ninety meshes to the lineal inch.

The proportion by weight of solid matter to water was that which was found to exist on the average of fourteen large rivers

[1] Report on the Mississippi River by Humphreys and Abbott, 1861.

[1] "Investigation on the Action of Sea Water in Accelerating the Deposit of River Silt" (*Min. Proc. Inst. C.E.*, vol. cxlii.).

when in flood, or ·79 lb. to a cubic foot equal to 1/80th part in weight of the water in the tubes.

Both sea water and water saturated with ordinary salt were tried, the latter in the proportion of one pound of salt to a cubic foot. There was no appreciable difference between these.

The samples were placed in glass test-tubes 1 foot long and ½ inch in diameter, filled with clean water up to the ten inch mark.

The material was well shaken and incorporated with the water, and the time given for settling is that taken by the particles to settle through 10 inches and become visible in a solid form at the bottom of the tube, and when no more particles could be discerned as settling when the tube was held up to the light.

The column "water clear" is that in which the water in the tube had become sufficiently transparent for black marks on a white ground to be discerned through it.

Practically all solid matter had settled in the time given in the first column. The quantity deposited between the interval of "settling" and "clear" was almost inappreciable, but still sufficient to keep the water discoloured. With the specimens containing the coarser material the water became bright again in the time given in the second column, but with the very fine material intervals varying from two to three hours up to as many days elapsed before the water became as bright as it was before the solid matter was added, partly depending on the fineness of the material, but due more to the staining quality of some of the ingredients contained in the sample. Thus the material taken from Tilbury Dock Basin turned the water a black colour which took some time to clear. The salt water took much longer to become bright again than the fresh.

Samples were selected as fairly representing the material brought down in suspension by rivers, or eroded from the sea cliffs, and deposited either in the form of salt marshes or transported to the bed of the sea.

Thus numbers 1 and 2 represent the sand found on the foreshores of the sea coast and covered at every tide; 3 and 4, material derived from chalk cliffs; 5 and 6, the material in suspension in the rivers Ouse and Trent, of which the Warp lands bordering on those rivers are composed, 5 being the material first deposited and near the river, and 6 that further away where the water remains quiescent for some time; 7 and 8 represent the material of which salt marshes are composed, 7 being the silt deposited on the sand, and on which, when it rises to about neap tide level, 6·68 above ordnance datum, samphire begins to grow, 8 the finer warp deposited from about the level of mean high water to that of ordinary spring tides, or 10·21 to 13·34 above ordnance datum, on which salt water grass grows; 9 is alluvial matter chiefly derived from the erosion of clay banks, brought up by the tides and deposited in Boston Dock, whence it was dredged, elevated from the barges and discharged with a current of water on to low land, the sample being taken at the part furthest away from the place of deposit; 10 was taken from the "batches" on the banks of the river Parrett at about half-tide level of spring tides, or 13·67 above ordnance datum, where the finest part of the alluvium in the river settles and which is collected for making bath bricks; 11 was taken from Tilbury Dock Basin on the Thames when the water was being stirred up by the eroding pumps; 12 is from clay used for brick making; 30 per cent. of the particles of this material were from 1/800th to 1/1000th inch in diameter and the remainder smaller than this, the average size being 1/1600 of an inch.

W. H. WHEELER.

The Subjective Lowering of Pitch.

IF the subjective effect described by Mr. E. Hurren Harding (*ante*, p. 103) is of general occurrence, it is contrary to what one might expect from the observation of singers.

It is well known that persons with a good ear may sing flat, being unconscious of the defect, though they would notice it immediately in other singers. From this it seems that the singer's voice sounds *higher* to himself than to others, and yet it is *louder* to him than to any one else. Sharp-singing, on the other hand, is regarded as more indicative of a defective ear.

I have no large tuning-forks at hand, but with ordinary forks and the sound-board of a piano I find that, on bringing the ear close to the source of sound, the sense of pitch is not altered, though the elements of noise are added to the sound; and these elements consist mostly of vibrations of lower pitch, presumably the proper notes of parts of the auditory apparatus.

In connection with this subject it may be noted that, owing to the structure of the cochlea, vibrations of small amplitude affect chiefly the lower part of its spiral; and that as the amplitude increases (independently of pitch?) the concussion reaches further up the spiral, where the fibres of the basilar membrane are longer than in the lower part, and therefore more responsive to slower vibrations.

F. J. ALLEN.

Malvern, June 9.

WITH reference to Mr. Harding's letter (p. 103), it would be interesting to know whether the effect he has observed with the voice, with tuning-forks and with organ pipes can also be obtained from a siren.

G. W. HEMMING.

YES; such effect can be obtained from a siren. If a siren be so rotated as to give a note approximating to middle C, the note appears flattened when the ear is placed close to the instrument, such flattening being estimated by different observers (at different times) as from a semitone to a whole tone.

Normal College, Bangor. E. HURREN HARDING.

THE NATIONAL ANTARCTIC EXPEDITION.

NO answer, so far as we are aware, has appeared to Prof. Poulton's letter to the Fellows of the Royal Society on Prof. Gregory's resignation of the leadership of the scientific staff of the Antarctic expedition (of which we published a copy on May 23). We are therefore forced to conclude that the representatives of this Society on the Joint Committee are content (to use our own words) to let judgment go by default, and admit Prof. Poulton's statements to be substantially correct. Since that date, according to a second letter which we published last week, rumours have been circulated that the real cause of Prof. Gregory's resignation was not that which had been publicly stated, but domestic considerations. The dates given to Prof. Poulton's statements and extracts from letters written by Prof. Gregory (which documents we have been allowed to examine) show these rumours to be baseless, and how they have arisen is no less a mystery than that alteration in the minutes of a resolution passed by the Joint Committee on February 14, 1900, mentioned in Prof. Poulton's former letter. Prof. Gregory's position has been consistent and definite throughout. He accepted the offer of the post on certain conditions, which he believed himself (not unreasonably, in our opinion) to have made clear. On returning to England last December he found the situation had been altered. Though not liking the changes he decided to accept them, and naturally supposed when he left England last February that the arrangement, concluded the day before he sailed, would be final. On receipt of a cable message that it had been further modified (by the acceptance, in substance, of Mr. Darwin's proposition), his first impulse, as he states, when the news arrived was to send a telegram announcing his resignation; but, after reflection, he thought it wiser to await the receipt of particulars by letter. Then came the refusal of the Council of the Royal Geographical Society to accept the instructions, thus modified, the appointment of an arbitration committee, as we may call it, and their decision, which virtually endorsed the action of that Society. When Prof. Gregory was informed by telegraph of the last step he at once cabled his resignation. We do not see how he could have done otherwise. There was now, to use his own words, "no guarantee to prevent the scientific work from being subordinated to naval adventure, an object admirable in itself, but not the one for which I understood this expedition to be organised."

Prof. Gregory, some experts have pleaded, is unreasonable in his expectations; the rules of the Service necessitate the complete autocracy of the naval officer in command. We content ourselves with the reply that if

this be so it is only one more instance of the deleterious effect of red tape in this country, of which we have just received, in the case of the War Office, so impressive, we may say so humiliating, a lesson. Others may ask: Why could not Prof. Gregory have shown a more trustful spirit and sailed in the *Discovery*, believing all things and hoping all things? There are limits even to faith. Had the commander of the expedition been a man distinctly his senior, already accustomed to scientific voyages, with some experience of polar exploration and those special problems which may be solved by the Antarctic expedition, Prof. Gregory might have ventured to dispense with securities and to feel confident that the interests of science would not be subordinated to the more showy work of adding new capes and islands to the map. But is this the case? The commander of the *Discovery*, we are informed, was, not many months ago, torpedo-lieutenant on a man-of-war, has had no experience in either Arctic or Antarctic seas, is no doubt well versed in those subjects of which a knowledge was demanded by his former post, may possibly be thoroughly competent to direct magnetic observations, but he has not as yet won the slightest reputation as a naturalist, a geologist, or an investigator of glacial problems. The last two qualifications are of exceptional importance in this expedition. They cannot be acquired on the voyage out, even by the help of a tutor; they demand, not only book learning, but also much practical experience. This Prof. Gregory possesses in an exceptional degree. He knows where a search for fossils will be the most hopeful and what will be of most value to palæontologists. He has mastered the literature of glacial questions, and he has studied glaciers themselves, in the Alps, Spitsbergen and elsewhere. He has travelled much, and on his notable expedition to Mount Kenya displayed powers of organisation, calmness in critical circumstances, physical endurance and moral courage which gave him at once a high place among explorers. He has a reputation to lose. Can he be expected to imperil that by absolute surrender to one who is probably his junior and is without experience in the branches of science of which he is a master? As Prof. Gregory truly remarks: "The position gives no power to secure a fair opportunity for work to the man who would have to bear the blame for scientific failure." It was not the position which he had originally consented to accept, it was not that which was agreed upon when he left England last February; so, perceiving that he was no longer supported by those whom he had regarded as representing the interests of science, he promptly withdrew from an untenable position.

The action of those representatives (or rather the majority of them) is inexplicable. They have worked, we hear it said, in the interests of peace. But there are occasions when even peace may be too dearly bought. "There must be give and take," one of them pleaded at a notable crisis. Certainly, but it has been all give on the one side and all take on the other. "The Council of the Royal Geographical Society," it was urged, "were acting within their rights when they rejected the instructions, as modified by their secretary." Certainly, so is one nation doing when it breaks off diplomatic relations with another, and in this way their action should have been regarded by the Council of the Royal Society. That body, or its representatives, seem to have adopted, at least during the present year, "a peace at any price" policy. In consenting to the appointment of a committee of arbitration they meekly accepted a snub, and in designating its members they exposed themselves to defeat. We have the highest respect for their nominees individually, but not one of them is a recognised expert in those branches of science the interests of which were most at stake. The other half of the court consisted of geographers—that is, of men who were really counsel for that side—and yet this court called no scientific experts to plead before it, though this had been virtually promised, but promptly gave its decision. Time would be saved if this practice were imitated in our law courts, but whether justice would be promoted is another question.

It has, however, been asserted that the Royal Geographical Society ought to be allowed a preponderant influence in the organisation of this expedition, because it had provided, directly or indirectly, most of the funds. This difficulty, however, is so obvious that it should have been foreseen at the outset, and the Royal Society have been careful to protect itself from being forced into a false position by inequality of contribution.

But we may go on to ask, does the Royal Geographical Society flatter itself that the Government would have made that grant of 45,000*l*. if its application had not been so energetically and heartily supported by the Royal Society? We venture to be sceptical on this point, and so to affirm that it was the duty of the latter body, at any rate after the rejection of the amended instructions by the Council of the Royal Geographical Society, to have announced that, while wishing all success to the Antarctic expedition, it could no longer be responsible for the guidance of its scientific work or the expenditure of public money. Now it must be content to follow whither the geographers lead. It will receive little honour for any successes, but will have to bear much of the blame if the scientific results are of small value. Its representatives have not afforded, as Prof. Poulton complained, to "the claims of the scientific chief in an expedition undertaken to do scientific work . . . that unflinching, undivided and resolute support" which not only he, but also those who set science above even geographical exploration, had expected and desired.

THE TELEGRAPHONE.

A DESCRIPTION of the telegraphone—the remarkable recording telephone invented by Herr Poulsen—was given in these columns in August last (vol. lxii. p. 371). At that time the instrument was on view at the Paris Exhibition, and though we were able the explain the principle upon which it was designed we could give no detailed description of the actual instrument, nor had we ourselves been able to test its powers. Since then it has been brought to England and has been exhibited at the Royal Society and at other places, where it has deservedly attracted a very large amount of attention. A further description may, therefore, in the circumstances be acceptable.

Herr Poulsen's invention fully deserves to be called one of the most astonishing that have been made of late years. That the delicate vibrations of the human voice could be changed into variations of an electric current and thus be transmitted over a distance and reproduced at the far end came as a surprise to men of science a quarter of a century ago. With no less surprise do we learn to-day that these telephonic currents, small though they are, can yet be used to create permanent magnetic fields in a steel wire, which will thus be made to serve as a tablet on which to write one's speech. It is not to be wondered at that when first Herr Poulsen's discovery was announced many were incredulous as to its genuineness; the invention is precisely of the kind that one does not believe could be practical until one has actually seen or heard it in operation. That it will have the effect of putting the phonograph on an entirely new basis no one who has heard it can doubt. The speech reproduced by the telegraphone is almost as much superior to that reproduced by the wax cylinder phonograph as are the living pictures of the kinematograph to those of the zoetrope. There is none of the very unpleasant twang inseparable from the

ordinary phonograph ; the speech is as clear and distinct as that transmitted through a good telephone.

In Fig. 1 is shown a photograph of one form of the telegraphone, in which the steel wire that is intended to receive the record is wound in a spiral on a drum, this drum being rotated either by a small motor or by hand, as shown. The little magnet which imprints the records on the wire is seen on the front of the drum with the wires leading from it to the transmitting or receiving telephone. The magnet is mounted on a small carriage, which slides on a bar going from right to left of the instrument at the top. At the back, attached to the same carriage, is a small plough, which engages with the steel wire on the drum and thus acts as a guide. When it is desired to speak to the instrument the magnet is started at the right hand side and the plough made to engage with the wire. The drum is then rotated, and as it turns the magnet moves from right to left, the wire passing all the time between its poles. During this motion any words spoken into a telephone connected to the magnet will be recorded as a series of magnetic fields on the wire. When the magnet arrives at the end of the wire the mechanical trip on the left of the instrument lifts the plough off the recording wire and makes it engage with a wire wound in a wide helix, which can be seen at the back ; this causes the carriage and magnet to return quickly to the starting point. To reproduce the record the magnet is connected to a telephone receiver and is again made to travel along the spiral ; as the now magnetised wire passes between its poles it sets up currents which reproduce the recorded speech in the receiver.

The record can be left on the wire and used over and over again ; it is not certain how long the record will last, as sufficient time has not yet elapsed to test this point. We heard a song in Danish which had been sung to one of these instruments some months ago, before it was taken away from Copenhagen ; though the song had been repeated a very great number of times it still seemed very distinct, though, being in Danish, we cannot venture to express any opinion on the articulation. If, however, it be desired to wipe out the record, a steady current is passed through the magnet coils as it travels from end to end of the recording wire ; this effectually destroys all the existing record and leaves the wire ready to receive a fresh one. This form of instrument is comparable to the ordinary phonograph in that it can only receive a record of one or two minutes' duration ; but, quite apart from its greater clearness, it is superior to the phonograph because the records can be so easily wiped out and fresh ones made.

Another form of telegraphone is shown in Fig. 2. In this a steel ribbon is used instead of a wire to receive the record. The ribbon is wound on two drums so that it can be unrolled from one on to the other. As it goes from one drum to the other it passes over the poles of the recording magnet, which is connected, as before, with the telephone receiver or transmitter. It is remarkable that although the convolutions of the ribbon when wound on the drums lie closely one above the other, the magnetic fields on one turn do not seem to interfere with those on another. With this arrangement it is easily possible to cut off any length of ribbon holding a particular record which it is desired to preserve.

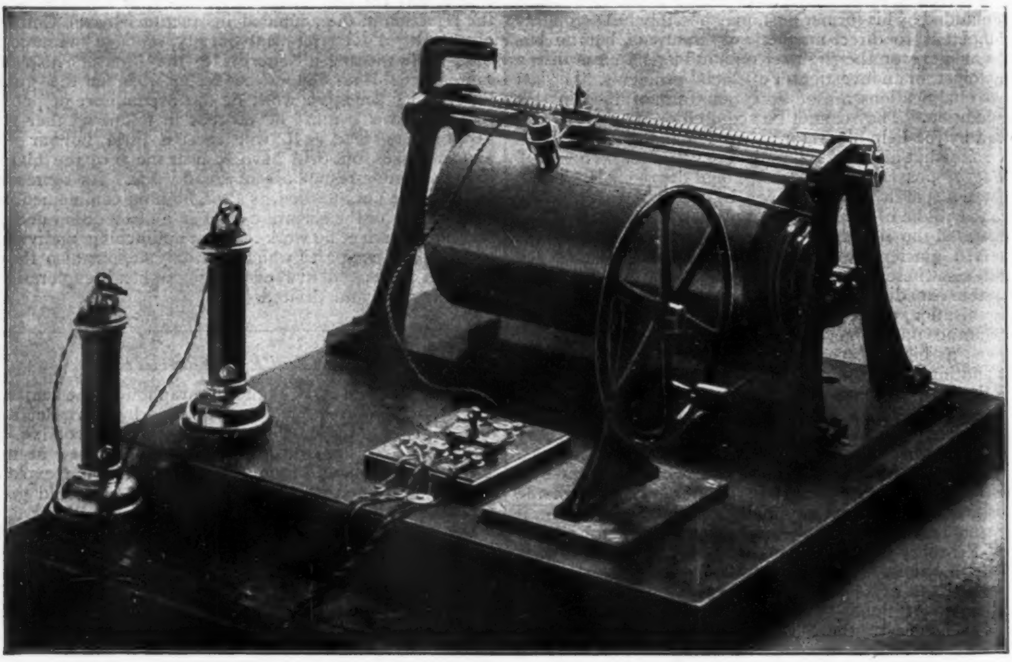


FIG. 1.—Steel Wire Telegraphone. (From the *Electrician*.)

A very ingenious apparatus has been devised by which a message may be transmitted simultaneously to any number of stations, an arrangement which should prove very useful for many purposes, for example for Press messages, &c. A diagram of this apparatus is shown in Fig. 3. An endless steel ribbon, R, passes round two pulleys, A and B, driven by a motor. This ribbon, after it leaves the pulley, A, comes to a strong permanent magnet, P, which wipes out any record existing on it. It then comes to a

magnet, M, connected with the microphone transmitter, and from this it receives a record of any words spoken. The ribbon, now carrying a record, next comes to a series of magnets, M_1, M_2, M_3 . . . each of which is connected to

From this arrangement is derived the telephonic relay to which we referred in our last article. Let the series of magnets M_1, M_2 . . . instead of being connected to distant receiving telephones be connected to a series of recording

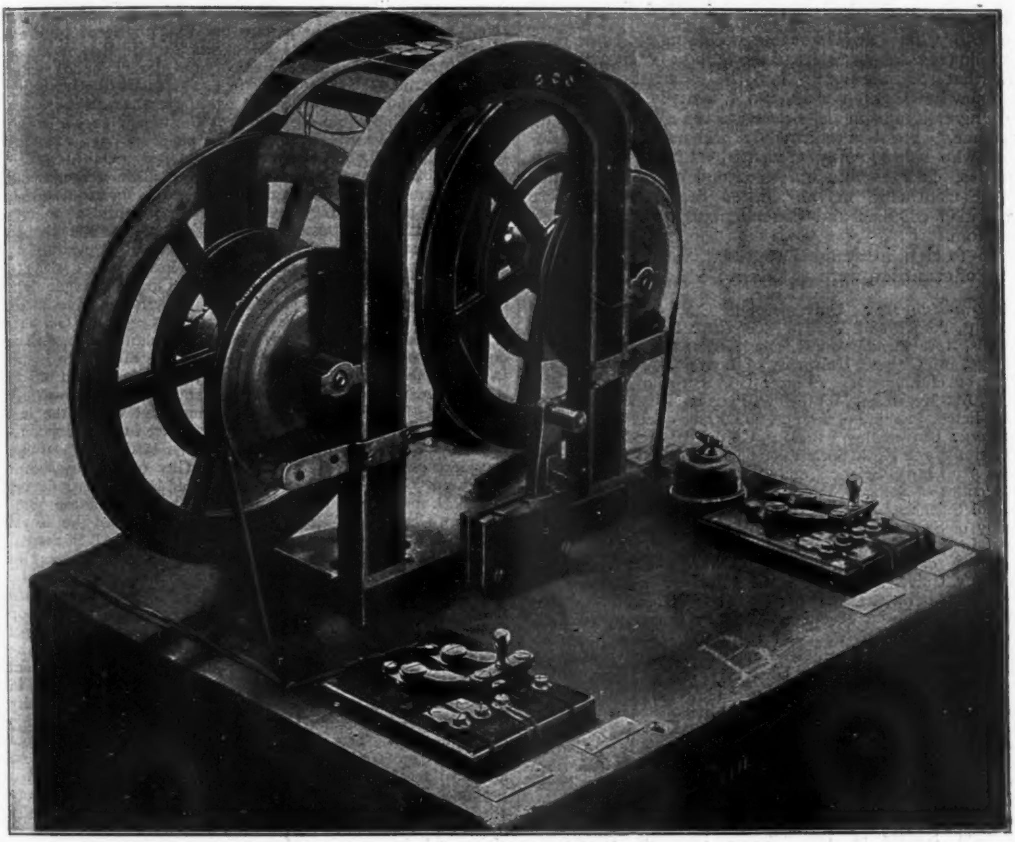


FIG. 2.—Steel Ribbon Telegraphone. (From the *Electrician*.)

a different circuit. The message is thus transmitted by the magnets, M_1, M_2 . . . to any number of distant stations at the same, or practically the same, moment. The ribbon after leaving the last magnet comes round again

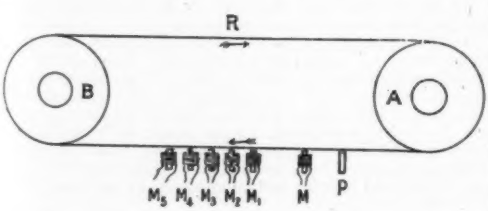


FIG. 3.—Distributing Telegraphone.

in due course to the permanent magnet, P, by which it is cleaned to receive fresh magnetisation; thus messages of any length can be sent by this means.

magnets which are used to produce records on a number of steel tapes. If all these steel tapes be made to repeat their record at the same instant to a single receiving telephone the loudness of the speech will be increased in proportion to the number of ribbons used.

We understand that successful experiments have been carried out on these lines, but that no actual relay has as yet been constructed. It is to be noted that as the energy is derived from the motion of the ribbons, and therefore from the motor used to drive them, there is theoretically no limit to the loudness that could be attained. If Herr Poulsen is really successful in constructing a telephonic relay, as there seems to be every prospect of his being, he will have accomplished a feat of immensely greater importance than the invention of an improved phonograph, or even of a satisfactory recording telephone. So far as this last point is concerned we learn that very successful trials have been carried out in America between Boston and New York. The ordinary telephone lines were used, the telegraphone being substituted for the receiver at one end; a good and clear record of the transmitted speech is said to have been obtained.

THE NINTH JUBILEE OF GLASGOW UNIVERSITY.

THE ninth jubilee of the University of Glasgow was celebrated last week with brilliant ceremony. The proceedings opened on Wednesday with a commemoration service in Glasgow Cathedral, when a sermon was preached by Dr. M'Adam Muir. In the afternoon Principal Story, the Vice-Chancellor, on taking the chair, read the following telegram from the King :—"I remember with what great pleasure I laid the foundation stone of your new buildings in 1866, and I heartily congratulate the University on the celebration of the 450th year of its existence." He then addressed a welcome to the delegates, who subsequently presented addresses from universities, colleges and other learned and public bodies on the Continent, in the United States of America, the British colonies and dependencies, and the United Kingdom.

The foreign institutions represented, in alphabetical order of countries, were as follows :—

Austria-Hungary: Universities of Cracow, Klausenburg, Lemberg, Prague and Vienna. *Belgium:* Free University of Brussels, Royal Academy of Science, Letters and Art, University of Liège, and Catholic University of Louvain. *Finland:* University of Helsingfors. *France:* Universities of Caen, Lille, Lyons, Aix-Marseilles, Montpellier, Paris and Rennes, Academy of Medicine, Institute of France, and Franco-Scottish Society. *Germany:* Universities of Breslau, Göttingen, Heidelberg, Kiel and Leipzig, and Royal Society of Sciences, Göttingen. *Holland:* Royal Academy of Sciences, and University of Utrecht. *Italy:* Universities of Bologna, Padua, Rome and Turin, Royal Academy of Sciences, Bologna, Royal Society of Naples, Italian Society of Science, Royal Academy of Sciences, Turin, and Royal Institute of Science, Letters and Art, Venice. *Japan:* University of Tokio. *Norway:* University of Christiania. *Portugal:* University of Coimbra. *Russia:* Universities of Kieff and Moscow, Imperial Society of Naturalists, and Imperial Military Academy of Medicine. *Spain:* University of Zaragoza. *Sweden:* Universities of Lund and Upsala. *Switzerland:* Universities of Bern, Geneva, Lausanne and Neuchatel. *United States of America:* University of Michigan, Johns Hopkins University, University of California, University of Boston, American Academy of Arts and Sciences, Massachusetts Historical Society, University of Chicago, University of Missouri, North-Western University, Dartmouth College, Cornell University, University of Wisconsin, Yale University, American Oriental Society, Columbia University, New York, Union Theological Seminary, New York, Leland Stanford Junior University, University of Pennsylvania, American Philosophical Society, Historical Society of Pennsylvania, Princeton University, Cooper Medical College, Columbian University, National Academy of Sciences, Smithsonian Institution, Clark University, American Philological Association, Archæological Institute of America, and Smith College.

The institutions in British Colonies and Dependencies represented at the celebration were :—

Australia: Universities of Adelaide, Melbourne and Sydney. *Canada:* Dalhousie University, Queen's College, Kingston, M'Gill University, and the University of Toronto. *India:* Universities of Allahabad, Bombay, Calcutta, Lahore (Punjab University) and Madras, and Asiatic Society of Bengal. *New Zealand:* University College, Auckland.

On the morning of Thursday there was a crowded attendance in the Bute Hall of the University to hear an oration on James Watt by Lord Kelvin, and another by Prof. Smart on Adam Smith, and to see the graduation ceremony at the conclusion of the addresses.

Lord Kelvin described Watt's career and achievements in an address of which the following is an abstract :—

The name of James Watt was famous throughout the whole world, in every part of which his great work had conferred benefits on mankind in continually increasing volume up to the present day. It was fitting that the University of Glasgow, in this celebration of its ninth jubilee, should recollect with pride the privilege it happily exercised 145 years ago of lending a helping hand and giving a workshop within its walls to a young man of no University education, struggling to begin earning a livelihood as a mathematical instrument maker, in whom was then discovered something of the genius destined for such great things in the future. In a note by Watt appended to Prof. Robison's dissertation on steam engines, he said that his attention was first directed in the year 1759 to the subject of steam engines by the late Dr. Robison, then a student in the University of Glasgow and nearly of his own age. He at that time threw out an idea of applying the power of the steam engine to the moving of wheel carriages and to other purposes, but the scheme was not matured, and was soon abandoned. On his going abroad about the year 1761 or 1762, Watt tried some experiments on the force of steam in a Papin's digester, and formed a species of steam engine by fixing upon it a syringe one-third of an inch diameter with a solid piston, and furnished also with a cock to admit the steam from the digester or shut it off at pleasure, as well as to open a communication from the inside of the syringe to the open air, by which the steam contained in the syringe might escape. That single acting, high-pressure syringe engine, made and experimented on by James Watt 140 years ago in his Glasgow College workshop, now in 1901, with the addition of a surface condenser cooled by air to receive the waste steam and a pump to return the water thence to the boiler, constituted the common road motor, which, in the opinion of many good judges, was the most successful of all the different forms tried within the last few years. Watt left Glasgow in 1774 to live in the neighbourhood of Dr. Erasmus Darwin, grandfather of Charles Darwin. But Greenock and the University and City of Glasgow never lost James Watt. The University conferred the honorary degree of LL.D. upon him in 1806. In 1808 he founded the Watt Prize in Glasgow College. He became Fellow of the Royal Society of Edinburgh in 1784, Fellow of the Royal Society of London in 1785, correspondent of the French Academy of Sciences in 1808, one of the eight "Associés Etrangers" of the French Academy of Sciences in 1814. Lord Kelvin did not know if any University in the world ever had a tradesman's workshop and saleshop within its walls, even for the making and selling of mathematical instruments, prior to 1757. But whether the University of Glasgow was or was not unique in its beneficent infraction of usage in this respect, it was certainly unique in being the first British University—perhaps the first University in the world—to have an engineering school and professorship of engineering. This began under Prof. Lewis Gordon about 1843. Glasgow was certainly the first University to have a chemical teaching laboratory for students started by its first professor of chemistry, Thomas Thomson, some time between 1818 and 1830. Glasgow was also certainly the first University to have a physical laboratory for the exercise and instruction of students' experimental work, which grew up with very imperfect appliances between 1846 and 1856. Pioneer though it was in those three departments, it had been outstripped within the last ten or fifteen years by other Universities and colleges in the elaborate buildings and instruments now needed to work effectively for the increase of knowledge by experimental research and the practical instruction of students. But there was no lagging to-day in the resolution to improve to the utmost in all affairs of practical importance, and they almost saw attainment of the further aspirations to excel over all others in the magnificent James Watt Engineering Laboratory of the University of Glasgow to be ready for work before the expected meeting of the Engineering Congress next September. Now, through the magnificently generous kindness of Mr. Andrew Carnegie to the people among whom he has made for himself a summer home in the land of his birth, all the four Scottish Universities could look forward to a largely increased power of benefiting the world by scientific research and by extending their teaching to young people chosen from every class of society as likely to be made better and happier and more useful to our country by University education.

The honorary degrees were afterwards conferred. The list was by far the longest that has ever been submitted at any graduation ceremony at the University. It included 22 Doctors of Divinity and no fewer than 120

Doctors of Laws, including several ladies. This is the first instance of the bestowal by the University of honorary degrees upon ladies.

The new botanical department of the University was opened by Sir Joseph Hooker on Thursday in the presence of a distinguished company. Sir Joseph Hooker prefaced the ceremony with a description of the work done by his father both before and after he became professor of botany in the University in the first quarter of last century. He had not been educated for the medical, or, indeed, any other learned profession. Having inherited ample means and having been from childhood devoted to the study and collection of objects of natural history, he determined to devote his life and his fortune to travel and scientific pursuits. Early in 1820, reduced circumstances requiring him to turn his botanical attainments to material account, he obtained, through the influence of his friend Sir Joseph Banks with George III., the chair of Regius Professor of Botany in this University. It was a bold venture for him to undertake so responsible an office, for he had never lectured, or even attended a course of lectures, and in Glasgow, as in all other Universities in the kingdom, the botanical chair was, and had always been, held by a graduate in medicine. Owing to these disqualifications his appointment was naturally unfavourably viewed by the medical faculty of the University. But he had resources that enabled him to overcome all obstacles—familiarity with his subject, devotion to its study, energy, eloquence, a commanding presence, with urbanity of manners, and, above all, the art of making the student love the science he taught. Continuing, Sir Joseph Hooker said :—

If I were asked what I regarded as of most importance to the student in the manner of my father's teaching I would answer that it taught the art of exact observation and reasoning therefrom, a schooling of inestimable value for the medical man, and one that is given in no other profession, but which ought to come, in this country, as it does in Germany, early in the education of every child. I have met many of my father's pupils abroad, in India and the Colonies, who have told me that these botanical lectures gave them the first ideas they had ever entertained of there being a natural classification of the members of the vegetable kingdom. Then with regard to the results in a botanical point of view, the magnetism of the lecturer and the interest of the subject imbued many of his pupils with a love of science that proved permanent and fruitful. They made observations and collections for their quondam professor in the temperate and tropical climates of both hemispheres, some of them throughout their lives, which have very largely contributed to a knowledge of the flora and vegetable resources of the globe. After twenty years of professorship my father retired, and undertook the directorship of the Royal Gardens, Kew. Since that period great changes have been introduced in the method of botanical teaching in all our Universities, due, on the one hand, to a vastly advanced comprehension of the structure of plants and of the functions of their organs, and, on the other, to a recognition of the fact that the study of the animal and vegetable kingdoms cannot be considered apart. Furthermore, chemistry, physics and greatly improved microscopes are now necessary for the elucidation of the elementary problems of plant life. The instruction in these two sciences (chemistry and physics) has with all others advanced in this University *pari passu* with that of botany, and kept it in the forefront of the educational establishments of the kingdom. The addition of the building in which we are assembled is evidence of the resolve that it shall not relax its efforts to maintain its well-earned position, and with the conviction that the botanical laboratory will prove an invaluable aid to research under the ægis of its distinguished director, I now, under his authority, declare it open.

The official celebration of the jubilee was brought to a close on Friday, when an oration on William Hunter, by Prof. Young, was read by Prof. Bower in the Bute Hall.

NOTES.

THE late Prof. G. F. Fitzgerald was so highly esteemed in the world of science that a movement to establish a memorial of his greatness will certainly meet with ready and liberal support. It is proposed to found a "Fitzgerald Research Scholarship," to be awarded annually at Trinity College, Dublin; and a large and influential committee of leaders of science at home and abroad has been formed to obtain funds for this purpose. The object is one which would have had the entire approval of Prof. Fitzgerald, whose chief care was the encouragement of experimental research in the laboratories entrusted to his guidance at Trinity College. The scholarship would be attached to the department of experimental physics in the College, and would enable promising students to pursue investigations which, for want of means of immediate support, might otherwise have to be relinquished. Prof. Fitzgerald's marvellous faculties and noble character are so well known and appreciated among scientific men that it is almost unnecessary to urge the claims of the object to their attention. We have confidence that the response to the appeal for funds will be sufficient to provide an adequate endowment for the scholarship it is desired to establish. Subscriptions should be sent to one of the honorary treasurers, Prof. D. J. Cunningham, F.R.S., or Dr. H. H. Dixon, Trinity College, Dublin.

A COMMITTEE has recently been appointed by the Institution of Civil Engineers, with the support of the Institutions of Mechanical Engineers and Naval Architects and of the Iron and Steel Institute, to consider the advisability of standardising the various kinds of iron and steel sections, and, if found advisable, then to consider and report as to the steps which should be taken to carry such standardisation into practice. The committee is composed as follows:—Mr. James Mansergh, Sir Benjamin Baker, K.C.M.G., Sir John Wolfe Barry, K.C.B., Sir Frederick Bramwell, Bart., Sir Douglas Fox, Mr. G. Ainsworth, Mr. William Dean, Mr. A. Denny, Mr. J. Allen McDonald, Mr. E. Windsor Richards, Mr. James Riley, Prof. W. C. Unwin, F.R.S., and Dr. J. H. T. Tudsbery (hon. secretary). Mr. Leslie S. Robertson, of 28, Victoria Street, S.W., has been appointed secretary to this committee, which has already commenced its work by taking evidence tendered by engineers, manufacturers and contractors bearing upon the subject of the inquiry.

THE Société des Amis des Sciences physiques et mathematiques at Poltava, Russia, is making arrangements to celebrate the centenary of the birth of Michel Ostrogradsky at Poltava on September 12-25 next.

THE following gentlemen have been elected to fill up vacancies in the list of foreign members of the London Mathematical Society:—Prof. Ulisse Dini, Pisa; Prof. Georg Cantor, Halle-a-Saale; and Prof. David Hilbert, Göttingen.

THE Berlin correspondent of the *Times* announces that an office has been opened in Berlin in order to co-operate in the preparation of an international catalogue of scientific literature. Dr. Oscar Uhlworm, chief Royal librarian, has been appointed to direct the work of the office.

THE Royal Horticultural Society will hold an exhibition of lilies at their Chiswick Garden, on Tuesday and Wednesday, July 16 and 17. On July 16 a conference on lilies will also take place in the Garden. The chair will be taken by Mr. H. J. Elwes, F.R.S., who will deliver an opening address on lilies discovered or brought into cultivation since the issue of his monograph on the subject.

THE fifth malarial expedition of the Liverpool School of Tropical Medicine, consisting of Major Ronald Ross, F.R.S., and Dr. Logan Taylor, left Liverpool for Freetown, Sierra Leone, on Saturday morning in the steamship *Axim*. It is proposed to attempt the extermination of the Anopheles mosquito on the West African Coast. The expedition has been equipped, free of expense, with large quantities of cement, petroleum, creosote and other means of attacking the Anopheles' breeding-grounds. The most dangerous time of the year, when the rainy season is at its worst, has been chosen as the most likely to test the efficacy of the intended operations.

AT a meeting of the subscribers to the Symons Memorial Fund, held on Tuesday, June 11, the executive committee reported that the proposal that the memorial to Mr. G. J. Symons, F.R.S., should take the form of a gold medal had been approved, and that the sum of 713*l*. 14*s*. 7*d*. had been subscribed for that purpose. After paying for the dies for the medal and the expenses of printing and postage, there remained a balance of 621*l*. 14*s*. 4*d*., which the treasurer was instructed to hand over to the Royal Meteorological Society for the interest on the same to be used for the awards of the medal. It was resolved that the medal should be awarded biennially for distinguished work done in connection with meteorological science, irrespective of sex or nationality.

AT the summer meeting of the Institution of Naval Architects, to be held at Glasgow on June 25–27, Lord Glasgow, president of the Institution, will occupy the chair. Among the papers to be read are :—" On the Limit of Economical Speed of Ships," by Mr. E. T. D'Eyncourt ; " On Screw Propellers" (abstracts of two papers by M. Drzewiecki) ; and "The Adoption of a Rational System of Units in Questions of Naval Construction," by M. Hauser, chief engineer in the French Navy (retired). The dinner of the Institution will be held on June 26 in the grounds of the Glasgow Exhibition, and will only be open to members and the official guests. The festivities include a conversazione at the invitation of the Lord Provost and the Corporation, a garden party at Kelburne, Lord Glasgow's seat, a reception at the University at the invitation of Principal Story and the Senate, and a cruise on the Firth of Clyde.

WE are indebted to *Science* for the following items of news :— Prof. Ira Remsen, professor of chemistry in the Johns Hopkins University since its foundation in 1876, has been elected president of the University.—A committee consisting of Prof. Ira Remsen, J. S. Ames and W. H. Welch has been appointed to arrange a memorial to the late Prof. Henry A. Rowland.—It is announced that Mr. John D. Rockefeller has given 200,000 dollars for the foundation of an institute for medical research, and it is understood that this fund will be increased as needed. At present America lacks an institution corresponding to the Pasteur Institute in Paris or the Jenner Institute in London. It appears that this need will be met by Mr. Rockefeller's gift, though the exact scope of the institution is still under consideration.

THE Council of the Society of Arts attended on Friday last at Marlborough House to present the King with the Albert medal of the society, which, as already announced, had been awarded to His Majesty " in recognition of the aid rendered by His Majesty to arts, manufactures and commerce during thirty-eight years' presidency of the Society of Arts, by undertaking the direction of important exhibitions in this country and the executive control of British representation at international exhibitions abroad, and also by many other services to the cause of British industry." The King said that he accepted the interesting medal, founded in memory of his lamented father, with much pleasure, because, during his long association with the Society of Arts as its president he had always taken a warm interest in its proceedings and its success. A special reason which enhanced the gratification with which he accepted the medal was that not many years ago he had himself, as president of the Society, presented it to his beloved mother, her late Majesty Queen Victoria. His Majesty added that, although he had retired from the active duties of the presidentship, he would continue to take a warm interest in the Society as its patron.

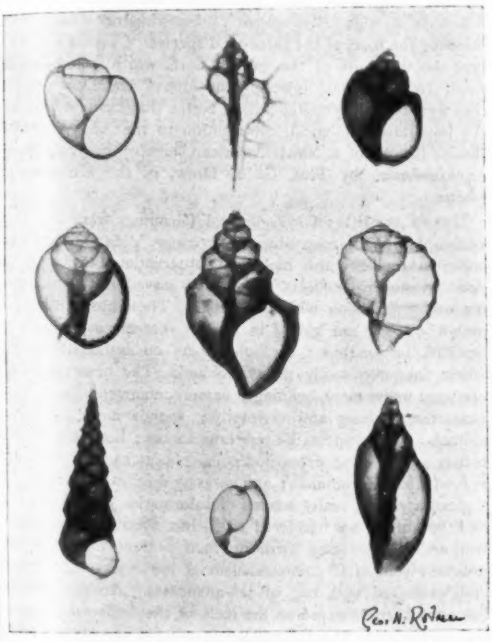
PROF. RAY LANKESTER has now received the case shipped at Mombasa on April 19, containing the skin and two skulls of the remarkable new giraffe-like animal obtained from the Semliki forest by Sir Harry Johnston, and sent by him for preservation in the Natural History Department of the British Museum. Writing to the *Times* with reference to the specimens, Prof. Lankester says : " The animal is a giraffe-like creature devoid of horns, with relatively short neck and with colour stripes on the limbs, but nowhere showing spots or areolæ like those of the giraffe. Sir Harry Johnston was amply justified in assimilating the animal to the extinct Helladotherium, but after an examination of the skulls I am of opinion that the 'Okapi' (the native name by which the new animal is known) cannot be referred to the genus of the Helladotherium, but must be placed in a new genus. I must say that, although the horny hoofs are not present, yet the double bony supports of the hoofs are preserved with the skin, and leave no doubt, even without reference to the accompanying skulls, that the animal which bore the skin was not a horse-like creature, but one with cloven hoofs."

IT is proposed to hold an exhibition on an extensive scale at Bendigo at the end of this year, under the auspices of the Government of Victoria, to commemorate the discovery of gold in 1851, and to celebrate the jubilee in a manner that will rank as a fitting memorial of the first anniversary of the Australian Commonwealth. Prominence will be given to the gold-mining and other mineral resources, and phases of mining in Victoria and other States, and special courts will be erected for the display of manufactures and industries, wool, agriculture, dairying machinery, &c. The Bendigo School of Mines will provide a model laboratory for the Exhibition, equipped with furnaces and apparatus for metallurgical and chemical work. There will be five main divisions of the exhibits and twenty-five sections, in which the applications of science to mining and to the development of other natural resources will be well represented.

DURING the past week the use of wireless telegraphy upon ocean liners has been satisfactorily demonstrated. A series of messages were despatched and received by passengers on the Cunard liner *Lucania*, which sailed from Liverpool on Saturday, and also by passengers on the Elder Dempster liner *Lake Champlain*, which reached the Mersey from Montreal on Monday afternoon. Stations have been established by the Marconi Company in connection with the Post Office wires, so that telegraphic messages can be received or despatched by passengers *en voyage*, the communication between the station and the vessel being by wireless telegraphy. The number of these stations is, as yet, not large, but there are enough of them to enable communication to be maintained, though with considerable intervals, from the time the vessel leaves Liverpool till she is an hour or so past the Fastnet. While in the Mersey she can speak with the training-ship *Conway*. As she steams along the north coast of Wales she gradually becomes within range of the station at Holyhead, which is about sixty-four miles from Liverpool. The next station is at Rosslare, in the south-east corner of Ireland, about ninety miles from Holyhead, and the last station is Crookhaven. Homeward bound vessels can pick up the stations in the reverse order. On Monday communica-

tion was established with Crookhaven by the *Lake Champlain*, and numerous service and private telegrams were despatched notifying the steamer's safe arrival off Ireland. The next station communicated with was Rosslare when forty-five miles distant. For more than five hours there was a continuous stream of messages, upwards of fifty being sent. Communication was next established with Holyhead, greetings being interchanged at a distance of 33½ miles. When 37¾ miles from Liverpool a message was received from the owners and orders were despatched instructing the captain to disembark passengers at the Princes' landing stage.

A SERIES of fine radiographs obtained by Dr. G. H. Rodman, of East Sheen, has been sent to us by Messrs. Cox and Co.; and as we admire the minute details shown by them, we appreciate the remarkable advances made in Röntgen ray photography since the first pictures were obtained six years ago.



1 Ampullaria. 2 Murex. 3 Eburna.
4 Cassis. 5 Struthiolar'a. 6 Dolium (young).
7 Turritella. 8 Bulla. 9 Voluta.

Four years ago a series of radiographs of all the British batrachians and reptiles was prepared by Messrs. Green and Gardiner and published. The application of Röntgen rays to biological study was well exemplified by these pictures, and also by radiographs of molluscs obtained later by the same observers, one of an entire Nautilus and another of an entire Chiton being particularly memorable. The uses of radiography to the study of the shells of the Mollusca are, however, not so well known as they deserve to be, and we are glad to direct attention to the accompanying pictures obtained by Dr. Rodman. The correct systematic position of many forms depends on the presence or absence of certain plaits, or folds, or tooth-like projections, either on the central shelly pillar (columella) or on the inner sides of the outer wall of the shell. These are frequently so situated as to be invisible through the aperture, and when only a single specimen may be available, which it is undesirable to sacrifice in the cause of science, the utility of radiography in this connection at once becomes apparent. The evidence of the accidental inclusion of a smaller shell (it is too large for an embryo) in No. 7 is noteworthy. Radiography may also be able to determine the mineral condition of the shell, whether the carbonate of lime in its substance takes the form of calcite or arragonite, or of the one in the young and the other in the older shell, as would almost seem to be the case in No. 7. On this point, however, further research is necessary. In the case of the recent Nautilus shell, the Röntgen process shows the details of every septum and the siphuncle with great clearness, as may be seen by reference to plate xv. of vol. xi. of the *Proceedings* of the Malacological Society of London. For the benefit of those who may wish to emulate Dr. Rodman, we may add that the exposure employed by him was 80 seconds at a distance of 11 inches on an Imperial Special Rapid plate, using a Cox 10-inch spark coil and their "Record" focus tube. This is the tube which has just been awarded the gold medal given by the president of the Röntgen Society, Dr. John Macintyre.

WE have received from the president of the International Aëronautical Committee a preliminary account of the balloon ascents on May 14. Eighteen ascents took place, including manned and unmanned balloons, of which six were at Berlin, four at Strassburg and three at Vienna. Two of the unmanned balloons have not yet been found. The highest altitudes were reached by the French balloons. One of these ascents, made from Chalais-Meudon, was particularly interesting: at starting the temperature was 15°·8 C., zero was recorded at 3661 m., −50° at 9640 m., and the lowest temperature, −55°·8, at 11,025 m.; but an inversion of temperature afterwards occurred, and on reaching the greatest altitude, 15,414 m., the thermometer had risen to −32°·2. Two balloons were sent up from Trappes (near Paris): one at 2h. 30m. a.m., which recorded 0° at 2740 m. and −64° at 11,400 m.; the other, at 8h. a.m., recorded zero at 2900 m. and −60° at 11,200 m. On this occasion no balloon was sent up by this country.

THE new standard pentane ten-candle-power lamp and the new form of photometer, prescribed for use in the official gas testing-stations in London, were described by Prof. Frank Clowes at a meeting of the Incorporated Gas Institute on Wednesday, June 12. The source of light in the new lamp is the flame produced by burning, under suitable and definitely prescribed conditions, a stream of carburetted air. The carburetting liquid is the light petroleum known under the chemical name of pentane. The liquid pentane evaporates rapidly at ordinary atmospheric temperatures, and the vapour which it produces is rather more than two and a half times as heavy as atmospheric air. As the name of the lamp implies, its flame has been shown to give under prescribed conditions a constant illumination equal to that furnished by ten standard candles. The new photometer differs in its arrangement from the bar-photometers which were previously in use in the fact that the flames under comparison are upon one side of the translucent screen, whereas in the old forms the burners were placed on opposite sides of the illuminated screen. But another essential difference from the older forms of photometer, which provided for one fixed and one travelling source of light, is that in the new photometer both sources of light are fixed in position at accurately measured distances from the observing screen. The equating of the illumination of the screen is brought about by adjusting the supply of the gas which is being tested to the Sugg's London argand-burner. The new photometer and standard lamp have now been in use for some time in the fixed testing-stations and in different buildings in the area of the county of London. The gas-examiners who have constantly employed the new apparatus express a decided preference for it as compared with the bar-

photometer; and they have readily adapted themselves to the somewhat special manipulation and observation which it requires

THE phenomenon of "accidental double refraction," which occurs in liquids when these are subject to changes of shape, or, to describe more correctly, rates of strain, forms the subject of an article by Prof. Ladislaus Natanson in the *Bulletin* of the Cracow Academy. The author gives an investigation, mainly hydrodynamical, of the case where the rates of strain are produced in a viscous liquid contained in the space between a rotating cylinder and a concentric cylindrical envelope. A formula is found connecting the angular velocity of the cylinder with the double refraction per unit length, and this formula appears to agree well with some of the experimental results of Umlauf and De Metz.

AN illustrated article on the Kress flying machine appears in *Die Umschau* for June 8. As has been stated in previous accounts in several journals, the apparatus is a multiple winged machine attached to a light boat, and the proposed method of experimenting is to drive the boat through the water until a sufficient speed has been attained for the thrust on the wings to cause it to rise from the surface. The writer of the article, however, evidently considers that the construction of the "air ship" has been somewhat prematurely pushed forward, seeing that the most important part of the apparatus, namely, the motor, is not yet ready. He also is of opinion that the problem of landing has not been sufficiently studied. Several experiments have already been made with the apparatus, without, however, leaving the water; but it will be when the machine has been made capable of lifting itself into mid-air that the chief difficulties of the investigation will arise.

THE fourth annual dinner of old students of the Central Technical College will be held on Wednesday, July 3, with Prof. O. Henrici, F.R.S., in the chair. Tickets can be obtained from the honorary secretary, Mr. Maurice Solomon, 12 Edith Road, West Kensington.

CAPTAIN STANLEY FLOWER sends us his Report, as director, of the Ghizeh Zoological Gardens for the year 1900. The list of donations is a satisfactory one, and we are glad to note that very much has been effected during the year in the way of adding new buildings and improving old ones, as well as in making additional aviaries and enclosures in the gardens.

IN the first part of a new biological journal—the *Bulletin* of the Brooklyn Institute—Mr. A. G. Mayer discusses the variations displayed by a species of Medusa from the Florida seas. The species in question is considered to have been derived very recently from a form common in Florida waters, but to be so distinct as to constitute a genus by itself. "It is remarkably variable, and its great commonness attests to its successfulness in the struggle for existence. In its variations it illustrates the manner in which other newly arisen races of animals may have suddenly given rise to still more diverse species."

PARTS ii. and iii. of the third volume of *Annotationes Zoologicae Japonenses* are devoted to a list of the fishes of Japan, by Messrs. Jordan and Snyder. A total of 686 species are recognised. Apart from its importance to the students of ichthyology, this communication is worthy of the best attention of those interested in the distribution of marine animals, as the authors have been enabled to divide the Japanese marine fish-fauna into four distinct groups. There are the northern or Yezo group, the temperate or Nippon group, the semitropical or Kiusiu group, and the Bassalian or deep sea group. The fish fauna of the Kurile Islands, which is probably very similar to that of Kamchatka, belongs to a distinct subarctic group, while that of Formosa probably pertains to the tropical Malayan assemblage.

THE structure of the hairs of the Patagonian ground-sloth and of the living South American edentates forms the subject of an essay by Dr. W. G. Ridewood, which appears in the May issue of the *Quarterly Journal of Microscopical Science*. The most generally interesting of the author's observations are those relating to the hairs of the two living types of sloth, and the structure which permits of the growth of an alga in each. In the three-toed sloth the hair is invested with a thick extra-cortical layer. "The layer has a tendency to crack in a transverse direction, and in the cracks there come to lodge unicellular algæ, to which Kühn has given the name *Pleurococcus bradypi*. The moisture of the climate in which Bradypus lives enables the alga to live and propagate in this curious position, and the sloth acquires a general green tint which must render it very difficult to distinguish as it hangs among the green foliage." In the two-toed sloth, on the other hand, the bulk of the hair is composed of cortex which is longitudinally fluted or grooved, the grooves being filled with strands of extra-cortex in which flourishes an alga (*Pleurococcus choloepi*) distinct from the one infesting the hairs of the three-toed species. Of quite a different type are the hairs of the ground-sloth, which are smooth and solid, Dr. Ridewood rejecting the idea of Dr. Lönnberg that they were originally coated with a cortex that has now perished. An important biological contribution to the same journal is the life-history of a North American bivalve mollusc, *Nucula delphinodonta*, by Prof. G. A. Drew, of the University of Maine.

UNDER the title of "Zoological Gleanings from the Royal Indian Marine Survey Ship *Investigator*," Major Alcock has collected together the biological observations made by the different medical officers who have served on board during his own connection with the vessel. These observations, the author tells us, are buried in reports that are not readily accessible, or scattered through papers on systematic zoology where they may easily be overlooked. The observations are arranged under eight headings, namely, commensalism; sexual characters, pairing and viviparity; sounds made by marine animals; notes on stalk-eyed crustaceans; instances of protective and warning coloration; phosphorescence; peculiarities in food of marine animals; and notes on reptiles and fishes. The "gleanings" are really a mine of information to the naturalist, and the author has rendered a distinct service to his fellow-workers in producing them in their present form. Among notable instances of commensalism is the case of the hermit-crab protected by a bag of sea-anemones. Another instance has often been observed on the reefs of the Andamans, where a crab of the genus Cryptodromia is protected by a sponge, which is shaped like a cap and tightly fitted to the crustacean.

GEOLOGICAL students and others interested in the science of the earth will find many desirable works in a classified catalogue of books and pamphlets on geology just issued by Messrs. Wesley and Son. The catalogue contains no less than 2225 titles of works in various departments of geological science, classified under 28 headings. It includes the geological library of the late Mr. G. H. Morton, of Liverpool. A glance through the catalogue will repay any geologist anxious to increase his library.

The cryptogams collected by Dr. F. Welwitsch in 1853–1861 are described by the botanists who have determined them in the new volume (vol. ii. part ii.) of the "Catalogue of Welwitsch's African Plants," published by the trustees of the British Museum. Though the plants were collected more than forty years ago, the collection is in some respects the most extensive and representative yet obtained from Africa. The species now described belong to the vascular cryptogams, mosses, hepatics, marine algæ, freshwater algæ, diatomaceæ, lichenes, fungi and mycetozoa.

A MEMORIAL of the late Dr. George Brown Goode, together with a selection of his papers on museums and on the history of science in America, has been published in the form of a volume by the Smithsonian Institution. Dr. Goode was held in the highest regard in all places where natural science is cultivated, and this account of his life and services will be cherished by everyone who is aware of the influence he exerted upon museum development. The addresses delivered at the memorial meeting held at the U.S. National Museum are printed, and also an appreciative notice of his life and services to science, by Prof. S. P. Langley. Eight papers are published in the volume, most of them dealing with museum administration and the pursuit of natural knowledge in America. There is much of interest in these papers concerning the growth of scientific institutions in the United States, and united they form an appropriate memorial of an accomplished man.

AN interesting synthesis of some aromatic aldoximes by means of fulminating silver is described by Messrs. R. Scholl and E. Bertsch in the current number of the *Berichte*. If a polyhydroxylic derivative of benzene is dissolved in ether, some fulminating silver suspended in the solution, and hydrochloric acid led slowly into the well-cooled solution, the silver fulminate disappears and the hydrochloride of the new aldoxime crystallises out. The method has been successfully applied to resorcinol, orcinol, pyrogallol and phloroglucinol.

THE same number of the *Berichte* contains an account by C. Harries of the preparation and properties of the dialdehyde of succinic acid. The aldoxime of this aldehyde can be prepared by the method of Ciamician and Dennstedt from pyrrol and hydroxylamine, and this, suspended in water and treated with nitrous acid, gives an aqueous solution of the new dialdehyde from which the pure substance can be isolated with some difficulty by fractional distillation. Succinic aldehyde is the first member of the aliphatic dialdehydes to be isolated in a pure monomolecular form, and is of interest as being the starting-point for the preparation of the three heterocyclic rings, furane, thiophene and pyrrol. The ready convertibility of this aldehyde into derivatives of these three rings is shown experimentally in the present note.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*) from India, presented by Mr. W. B. Bingham; an Otter (*Lutra vulgaris*, ♂), British, presented by Mr. W. Radcliffe Saunders; twelve Black Vultures (*Cathartes atratus*) from America, presented by Dr. E. A. Goeldi; two Cambayan Turtle Doves (*Turtur cambayensis*), a White-collared Ouzel (*Merula albicincta*), a Large Andaman Parrakeet (*Palaeornis magnirostris*), a Tickell's Flower-pecker (*Dicaeum erythrorhynchus*), a Cinnamon Tree Sparrow (*Passer cinnamoneus*), a Rufous-breasted Accentor (*Tharrhaleus strophiotus*), a Black-throated Accentor (*Tharrhaleus atrigularis*), an Eastern Meadow Bunting (*Emberiza stracheyi*), four White-capped Buntings (*Emberiza stewarti*), two Indian Button Quails (*Turnix tanki*) from British India, presented by Mr. E. W. Harper; a Northern Mocking-bird (*Mimus polyglottus*) from North America, presented by Mr. H. C. C. Gülich; an Antillean Boa (*Boa diviniloque*) from the West Indies, presented by Mr. D. F. Mackenzie; a Sykes's Monkey (*Cercopithecus albigularis*) from East Africa, a Chacma Baboon (*Cynocephalus porcarius*) from South Africa, a Smooth-headed Capuchin (*Cebus monachus*) from South-east Brazil, two Wanderoo Monkeys (*Macacus silenus*, ♂ ♀), a Banded Parrakeet (*Palaeornis fasciata*), a Ring-necked Parrakeet (*Palaeornis torquata*), two —— Snakes (*Cerberus rhynchops*), thirteen —— Fish (*Saccobranchus fossilis*) from India, a Golden-naped Amazon (*Chrysotis auripalliata*) from Central America, a Leadbeater's Cockatoo (*Cacatua leadbeateri*) from Australia, a Shining Parrakeet (*Pyrrhulopsis splendens*) from the Fiji Islands, a Blue-winged Green Bulbul (*Chloropsis hardwicki*) from British India, two Japanese Terrapins (*Clemmys japonica*) from Japan, a Blue Lizard (*Gerrhonotus caeruleus*) from Western North America, deposited; two Chinchillas (*Chinchilla lanigera*) from Chili, purchased; a Llama (*Lama peruana*), a Hybrid Lemur (between *Lemur xanthomystax* and *L. brunneus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

OBSERVATIONS OF NOVA PERSEI.—In the *Mem. de la Soc. degli Spett. Ital.* (vol. xxx. pp. 77–90), Prof. A. Ricco describes the observations of the brightness and spectrum of Nova Persei, made at the Catania observatory. The various magnitudes given are similar to those already published by other observers, the light curve showing distinct oscillations from March 8.

The spectra were observed with the Merz refractor of 0·33 metre aperture and McClean star spectroscope, and photographs obtained with the photographic equatorial and Vogel spectrograph, the spectra being about 43 millimetres long, with exposures of one hour. The wave-lengths are given as follows:

3933 K	... 4179	... 4541	... 4923
3969 H	... 4235	... 4587	... 5019
4015	... 4310	... 4609	... 5168
4039	... 4341 Hγ	... 4636	... 5300
4071	... 4412	... 4681	... 5551
4102 Hδ	... 4493	... 4862 Hβ	... 5627

COMET 1901 *a*.—The comet is now getting so far away from the sun that it is in all probability beyond the reach of any but the largest instruments. The following ephemeris may be of service to those having sufficient optical power:—

Ephemeris for 12h. Berlin Mean Time.

1901.	R.A. h. m. s.		Decl. ° ′
June 21	7 24 56	...	+10 8·3
23	28 6	...	10 16·1
25	31 9	...	10 23·1
27	34 7	...	10 29·5
29	7 37 0	...	+10 35·2

NEW VARIABLE STARS:—

74, 1901 (Persei). Herr P. Guthnick, of Bonn, finds that the star

$$\left.\begin{array}{l}\text{R.A.} = \ 3^{h}\ 2^{m}{\cdot}7 \\ \text{Decl.} = +44^{\circ}\ 29'\end{array}\right\}(1900)$$

is variable to the extent of 0·6 magnitude. From the table of magnitudes given the period would appear to be about thirty days, but the gaps are too long for any accurate estimate. This star is the intensely orange-coloured χ Persei.

75, 1901 (Persei). Herr Fr. Deichmuller, of Bonn, finds variability in the star 36 Flamsteed, amounting to about 0·5 magnitude. The observations indicate a change from 4·92 to 5·65 magnitude twice a month. The variability of this star is confirmed by Herr Guthnick (*Astronomische Nachrichten*, Bd. 155, No. 3720).

FORMS OF IMAGES IN STELLAR PHOTOGRAPHY.—In the *Annals* of Harvard College Observatory (vol. xli. No. vi. pp. 153–187), Mr. E. S. King, the observer in charge of the photographic department at that institution, describes the various disturbing causes which affect the forms of star images obtained by photographic methods with different systems of following. The chief of these are irregularities of the driving clock, differential refraction, and flexure. To correct these errors two methods of guiding have been employed, the plate being moved by suitable adjusting screws, either with the telescope or independently of it, the latter method being preferred, as it permits, not only corrections in two coordinates perpendicular to each other, but also a rotary movement for the elimination of flexure and differential refraction.

The investigations described have been in hand since 1896, when they were undertaken in consequence of difficulties occurring in the observation of the Algol variable W Delphini

at low altitudes. A fourth source of error, in the adjustment of the polar axis, must be also considered, and it is practically important to do this, inasmuch that by an accurate knowledge of the conditions it is possible to introduce such an amount of error from this and the clock rate as to partially eliminate the variable errors due to flexure, &c. After insisting on the necessity of the clock having as continuous and regular motion as possible, it is pointed out that the correct rate for following is not sidereal time, as is commonly supposed, but a variation from this depending on the latitude and the declination of the object. The equations of condition are developed for determining the proper following rates for various localities. The actual path of a star on the plate as affected by refraction may be either a parabola, hyperbola, ellipse or circle. The effect of error of the polar axis is an elliptical form of star image, varying with the declination. The analytical investigation of this shows that the refraction in declination can to a great extent be eliminated by an alteration of the inclination of the axis; this is now provided for in many instruments by the frequent shifting of the polar axis by known amounts. The correction for the right ascension component is more complicated, and tables are given showing the changes per hour for various hour angles. Reproductions from photographs taken with clock rate adjusted for refraction and polar axis elevated are shown. In considering the effects of flexure three kinds are discussed, affecting either the polar or declination axes, and the tube. Various methods actually in use at the Observatory for determining the flexure are then described in detail, also the exact method of varying the load of the control pendulum governing the driving clock. The effects of temperature on the trails have also been considered, and methods for its elimination.

As the result of the investigation, it is found that plates of 60 minutes' exposure may be taken without visual following, which shall have images not exceeding 0·01 cm. in elongation due to the clock, and a photograph of the cluster in Hercules taken in this way is reproduced. Several special applications of these principles are then discussed, including the important one of photographing stellar spectra with the objective prism, where the spectrum lines are often very oblique, thus lessening the dispersion and possibly the definition. A table is calculated showing that this may be corrected by a slight rotation of the prism for each star.

Several methods for the mechanical correction of flexure are indicated, and finally the special means for correcting proper motions of the object under examination are considered, examples of the photographs of Eros being given in illustration.

THE SIXTH ANNUAL CONGRESS OF THE SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES.

THIS Congress was held at Haslemere and Hindhead on June 6–8, and delegates and members representative of most of the affiliated societies upon the Union's list were in attendance. There were, further, a goodly number of visitors present, attracted to a large extent by the unbounded hospitality of the residents and admirable arrangements of the local committee, which were most elaborate and highly successful.

The proceedings were opened by Prof. G. B. Howes, F.R.S., who, as the retiring president, in a few apposite remarks resigned the chair to his successor, Mr. G. A. Boulenger, F.R.S., who then delivered the annual address. Taking for his subject the field-work and results of experiment of the past quarter of a century upon the European Reptilia and Batrachia, he led up to the formulation of a revised list of the British species. He then dealt in greater detail with those genera and species inhabiting the immediate neighbourhood of the meeting, special interest attaching to some facts involving the natterjack and Gilbert White's area of observation, in their relation to the topic of batrachian migration; and he seized the opportunity to enlist the services of local naturalists in the study of this problem, in the better working-out of the varieties of the common viper, and in other allied herpetological matters for which the study of the local fauna presents a favourable opportunity. Beyond this the address, which was admirably suited to the occasion, contained historical records of permanent value and some wholesome advice to the collector and would-be specialist, based upon the author's great experience of herpetological affairs.

The meetings for strictly scientific business were confined to the Friday and Saturday mornings, five papers being read. An unusual departure, however, was entered upon, in the substitution of three short addresses for the musical entertainment customary on similar occasions at the evening *soirée*. The reception at this was by Sir F. Pollock, Bart., and in his capacity as president of the local natural history society he delighted those present with a felicitous speech. The short addresses which followed this were by Mr. G. F. Chambers, on "An Eclipse Trip to Portugal in 1900"; by Mr. Oswald Latter, of the Charterhouse, on "Cuckoos' Eggs"; and by Dr. Jonathan Hutchinson, F.R.S., on "Habit and Discipline in their Influence on Organisation." The latter, on the lines of the famous Sunday afternoon discourses with which the indefatigable doctor is in the habit of improving the minds of his friends and visitors, both at Haslemere and in London, was noteworthy for the attempt to prove that the orbital bulla of the hippopotamus, shown to be different in origin in each of its two stages of development, is, like that of the gavial, functional as a support for the eye during protraction and elevation; and for the thesis that in human affairs the poet must precede the philosopher.

Dr. Hutchinson further contributed to the educational success of the meeting by entertaining the assembled guests at his private museum at College Hill, the originality of the plan of arrangement of which was much admired; and, with characteristic versatility, he followed this up by leading the way to Lord Tennyson's abode at Blackdown, before which, after a visit to its interior, verses appropriate to the occasion were by him and others recited.

Of the papers read at the ordinary meetings, the first, by the Hon. Rollo Russell, on "Moisture in the Atmosphere," is the embodiment of a lengthy series of experimental and statistical observations which will be of much service for reference. This was followed by a paper by Miss E. Sargent on "Seedlings," chiefly noteworthy for some observations made in conjunction with "a colleague," in which a downward displacement of the seed by forcible contraction of the roots was fully described and illustrated by an ingenious model. Prof. Howes concluded the first morning's work with a short lecture, which he said was pertinent to his presidential address of the previous year. He dealt with the principle of "convergence," as applying more especially to recent work among the Mammalia and Batrachia ecaudata, and with "substitution" in its bearings on the study of the electrical organs of fishes.

The afternoon of Friday was given to the reading of a couple of papers on "The Teaching of Nature Knowledge in Elementary Schools," by Miss M. A. Buckton, who has had considerable experience of elementary school-work both on the Continent and at home, and by Prof. A. D. Hall, principal of the Wye Agricultural College. Upon these a discussion arose, which, for lack of organisation beforehand and time for extension, fell short of what might have been an important issue.

The concluding paper of the meeting was by Mr. S. T. Dunn, secretary to the Director of Kew Gardens, under title "The Origin of Certain Weeds." The author read an account of the geographical distribution of certain dead nettles, and in the short discussion which ensued doubt was expressed whether he had pointed to anything which does not apply to certain other British plants well known, while there arose a difference of opinion which left the audience in uncertainty as to what constitutes a "weed."

At the meeting of delegates, which closed the proceedings, the question of subscription was discussed; and conspicuous among the motions passed was one of appeal to the Brighton Town Council, who are about to take the famous Aquarium of that town in hand for development, to make adequate provision for scientific investigation and work in economics, in a manner which was agreed upon.

The exquisite country in which the meeting was held and the delightful weather which prevailed proved both beneficial and attractive, and not the least pleasurable feature of the Congress was the manner in which the influential residents, both by their generous hospitality and personal interest, contributed to its success, while the vociferous croaking of some introduced frogs came as a most appropriate accompaniment to the proceedings.

The Congress for 1902 is to be held at Canterbury, under the presidency of Dr. Jonathan Hutchinson, F.R.S., who has served the recent one so well.

SOME RECENT WORK ON DIFFUSION.[1]

II.

WE have seen that when steady diffusion is going on down a cylindrical column which is absorbent at the bottom there is a uniform diminution in the density of the diffusing substance from one end of the column to the other, evidenced in the case of a coloured substance by a gradual and uniform thinning out of the colour in the direction of the axis of the column. But in any horizontal cross-section of the column the colour is of the same intensity in all parts of the section, which means, of course, that the diffusing substance is of equal density along these planes.

In a diagrammatic section of such a column we should therefore represent the surfaces of equal density by straight lines drawn at right angles to the axis of the cylinder, and the stream lines of the diffusing substance by straight lines drawn parallel to the axis.

I am able to show you the horizontal lines of equal density in a cylinder, produced by a process of intermittent diffusion presently to be described.

When diffusion goes on into a flat absorbent disc, or aperture, instead of into a cylinder, it is clear that the stream lines of the diffusing substance must strongly converge towards the disc instead of moving vertically downwards as they do in the cylinder, and it is also clear that the lines or surfaces of equal density in the diffusing substance must form curved surfaces of some kind over the disc. We must now consider the exact form which these lines and surfaces will take.

It so happens that there is a problem in electrostatics which is analogous to the one before us, and it is one which has been fully worked out by mathematical physicists.

When an insulated conductor receives an electric charge the form taken by the surfaces of equi-potential around the conductor

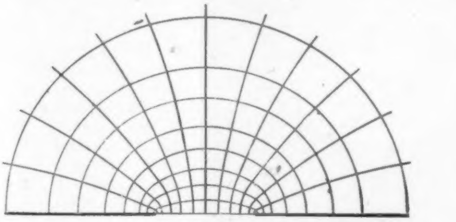


FIG. 1.

depends on its shape, and on the nature and distribution of other charges in its neighbourhood.

If we suppose the absorbing disc or perforation used in our diffusion experiments to be replaced by an electrified disc of similar dimensions, embedded flush in a wide non-conducting rim, then the surfaces of equal electric potential in the air above the disc will take the form represented in Fig. 1. The surfaces will form a series of hemi-spheroids which in any vertical section passing through the centre of the disc will give a series of ellipses, having their common foci in the edges of the disc. Faraday's lines or tubes of force, on the other hand, will in this case be represented by a series of hyperbolas, also having their foci in the edges of the disc.

Now we have every reason to believe that in a diffusion experiment with an absorbent disc the surfaces of equal density of the diffusing substance over that disc are the exact analogues of the surfaces of equi-potential over the similar electrified disc, and that the stream lines of the diffusing substance are the analogues of the lines or tubes of force. If this is so the diagram will equally well represent an experiment in which, for instance, the carbonic acid of perfectly still air is being absorbed by a disc of soda solution, surrounded by a wide rim.

Fig. 2 represents what we might expect to be the state of things when diffusion takes place through a circular aperture in a diaphragm. Here the stream lines of the substance, which are convergent as they approach the aperture, diverge again when the opening is past, and we should expect to get a double system of the ellipsoidal zones of equal density on either side of the aperture.

Did time permit I could show you that this hypothesis is not only capable of giving reasonable and consistent explanations of all the phenomena of diffusion into and through apertures, but completely explains the "diameter law," and also enables us to predict the amount of gas, vapour, or solute which will pass under given conditions, and the results can be verified by experiment.

I have only time to glance at one or two readily verifiable deductions from this hypothesis. In the first place, it fully accounts for what I have called the "diameter law," that is to say, that diffusion through circular apertures in a diaphragm is proportional to their diameters, not to their areas.

In two diagrams on the wall we have represented the arrangement of the equi-density curves and stream lines over two absorbent discs, one double the diameter of the other. We may take these discs to represent an alkaline solution absorbing carbonic acid from the air.

The two systems are on the same relative scale, but one is magnified by two diameters.

It will be seen that a curved line corresponding to any given actual density of the diffusing substance must be twice as far from the surface of the larger disc as it is from the surface of the smaller; that is to say, the *gradient of density* on which the flow depends is twice as steep over the small disc as it is over the large one. From this it follows that for equal areas the flow into the smaller disc is twice that into the larger and that the *total* flow must be proportional to the diameters, which is just what is found to be the case.

Wherever we get conditions favourable for the formation of a

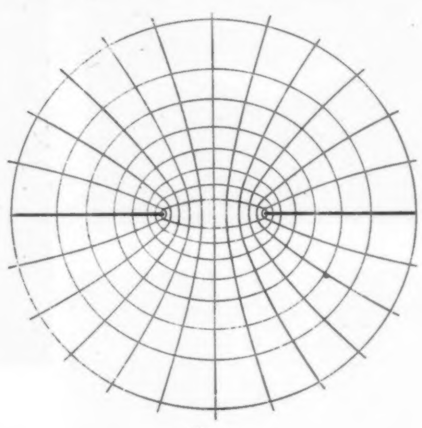


FIG. 2.

system of equi-density zones on one or both sides of a perforated diaphragm, diffusion will go on in accordance with this "diameter law." But one system of zones is quite sufficient for the purpose, so that in a case like that of Fig. 2, which represents the course of diffusion of atmospheric CO_2 in perfectly still air into an absorbent chamber, we might allow the outer system of equi-density shells over the aperture to be completely swept away by air currents, and still the "diameter law" would hold good on account of the inner series of zones, which, from their position, are protected from the air currents. This explains in a very satisfactory manner why it is much more easy to demonstrate the diameter law with apertures in a diaphragm than simply with absorbing discs, where only one external system of equi-density shells can exist, which is, of course, extremely liable to be influenced by disturbing currents.

Satisfactory, however, as this hypothesis is in explaining everything connected with these curious facts of diffusion, it must be borne in mind that the reasoning on which it is based is in part deductive and in part dependent on an analogy.

Nearly 300 years ago it was said by Sir Thomas Roe that "many things hold well in discourse, and in the theorique, satisfie curious imaginations, but in practice and execution are found difficult and ayrie."

Fortunately this does not apply to the present case, and I am able to bring before you this evening for the first time an experimental demonstration of the existence of zones of equal density in the neighbourhood of an aperture through which diffusion is

[1] Discourse delivered at the Royal Institution, Friday, March 22, by Dr. Horace T. Brown, F.R.S. (Continued from p. 174.)

going on, and to show you that they have the exact shape which the theory requires.

I have here a rectangular glass cell divided horizontally by a thin plate of celluloid having a circular hole punched through it. The lower half of the cell is filled with a solution of gelatine containing a little barium chloride, and the upper half with a solution of sodium sulphate.

The relative strengths of the solutions are so adjusted that the two salts, diffusing in opposite directions, shall meet somewhere in the gelatine where a precipitate of barium sulphate is thrown down at the surfaces of contact of the two opposing streams of diffusion. The result is that we get a slowly growing, spheroidal mass of precipitate, starting from the aperture and resembling in shape the head of an inverted mushroom.

If we arrange for the diffusion of the sodium sulphate to be intermittent, or, better still, if we alternate the diffusion of a sulphate with that of a chromate, we get well-marked *zonings* in the precipitate forming the spheroid, zonings which correspond to the successive forms which the spheroid has assumed during growth, and which, therefore, must have been zones of equal density of the diffusing substances. We can study the forms which these assume in relation to the aperture by subsequently cutting sections through the gelatine, but by a little arrangement we can make the apparatus cut its own sections as the diffusion goes on.

This is done by making the aperture in the diaphragm *semi-circular* instead of circular, and bringing its straight edge close up to the side of the glass vessel.

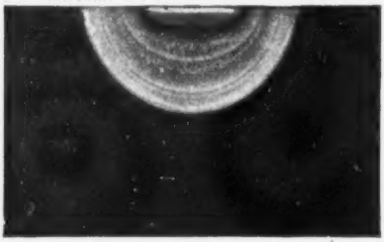


FIG. 3.

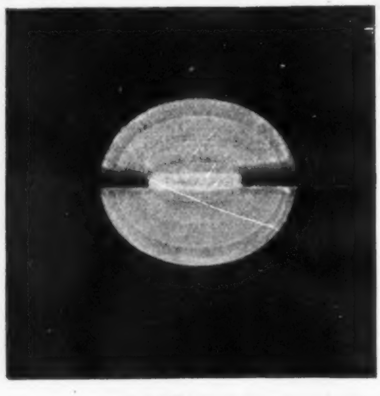


FIG. 4.

I will now throw on the screen some photographs of vertical sections of spheroids of diffusion of this kind. (See Fig. 3 and Fig. 4).

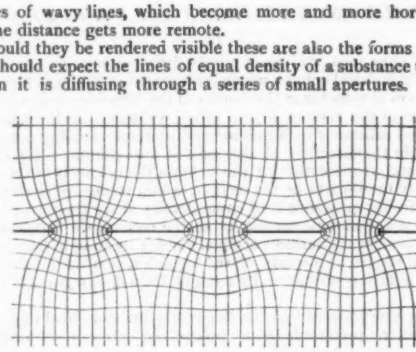
On comparing the lines of equal density around the aperture with the diagrams on the wall you will at once see that their shape is exactly that required by theory—they describe a series of ellipses having their common foci in the edges of the aperture through which the diffusion is taking place.

The actual stream lines of the diffusing substance are not visible, but as these must necessarily be normal to the curves of equal density they can only be represented by a series of hyperbolas, also having their foci in the edges of the aperture.

The electrostatic analogy which has served us so well in determining the form of the zones of equal density around *single* apertures may also be used for predicting their distribution around a series of apertures in a diaphragm.

If we regard the individual holes in a multiperforate diaphragm as so many minute discs, all electrified to a common potential, the lines of equi-potential and the lines of force should take a form something like that represented in the diagram, Fig. 5, the lines of equi-potential forming complete ellipses in the immediate neighbourhood of the electrified discs, but gradually intersecting and forming a series of wavy lines, which become more and more horizontal as the distance gets more remote.

Could they be rendered visible these are also the forms which we should expect the lines of equal density of a substance to take when it is diffusing through a series of small apertures. I am able to give you a verification of this by throwing on the screen photographs showing the result of intermittent diffusion through a series of such apertures (Figs. 6 and 7). The lines of equal density are marked out by the alternate bands of sulphate and chromate of barium as they were in the last experiment.



IG. 5.

From the shape of these lines of equal density it is possible to determine the form of the stream lines of the diffusing substance and to show that the tendency of a multi-perforate septum of this kind is to locally increase the gradient of density in its neighbourhood and so to accelerate the flow through the small apertures. We get, in fact, a complete and satisfactory explanation of the small amount of obstruction which such a diaphragm produces when put in the way of a diffusive flow of gas or liquid.

Intermittent diffusion such as I have described may be used to illustrate in a variety of ways the distribution of electric potential around electrified bodies which are within the sphere of each other's action.

It is generally a difficult and laborious task to work out the distribution of the surfaces of equi-potential around electrified bodies which are near enough to influence each other. By this system of intermittent diffusion we may sometimes make Nature work out the problem for us. Here, for instance (see Fig. 8), is a figure copied from Clark Maxwell's "Electricity and Magnetism," representing the form which is assumed by equi-potential surfaces around two points charged with quantities of electricity of the same kind in the ratio of 4 to 1. If the analogy is

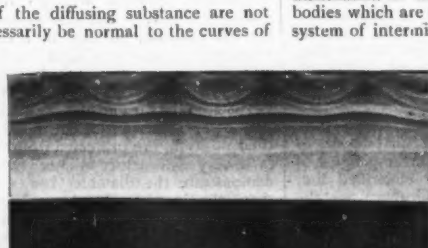


FIG. 6.

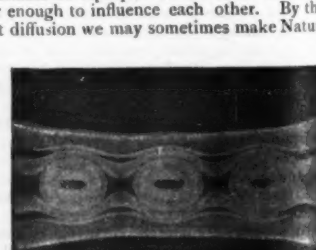


FIG. 7.

correct diffusion, through apertures having their diameters in the ratio of 2 to 1 ought to give the same series of figures. You see from the photograph of an actual experiment given in Fig. 9 that this supposition is correct.

In Fig. 10 are given the calculated lines of force at the edges of two parallel plates, one of which is insulated and electrified, the other connected with the earth. These ought to correspond in shape to the equi-density lines of a substance undergoing steady diffusion from between two parallel plates, as, in fact, you see they do. (See Fig. 11).

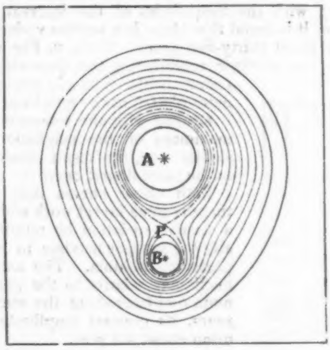


FIG. 8.

But considerations of this kind, although of interest in showing the striking analogies between certain phenomena of electrostatics and static diffusion, would carry me too far from my main subject, and I must again bring you back to the green leaf which was the starting point of my lecture.

If we regard the structure of the leaf from the new point of view which now suggests itself we can readily understand how it is that the stomates, notwithstanding the relatively small area of the leaf surface which they occupy, can drink in the atmospheric carbonic acid with such rapidity.

The finely perforated epidermis of the leaf, tightly stretched over the interior air-spaces, whose walls can absorb carbonic acid, constitutes a multiperforate septum which is under the most favourable conditions to produce an acceleration of the diffusive flow of the gas into the leaf.

The laws of gaseous diffusion through small apertures are now so well understood that we can predict with certainty the particular quantitative effect produced on a given diffusive flow by any screen with perforations of known size and distribution providing they are not within a certain number of diameters distant from each other. These deductions can then be verified by experimenting with small shallow glass cylinders, made absorbent inside, and closed at the top with very thin discs of celluloid perforated in a known manner. Such a piece of apparatus may be regarded as an artificial leaf, the perforated celluloid representing the epidermis with its stomates, whilst the absorbing solution of caustic soda acts the part of the assimilating centres.

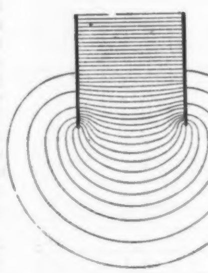


FIG. 10.

Having obtained confidence in the accuracy of the method of calculation we can then apply the same principles to determining the efficiency of the leaf stomates, when the whole system is regarded as a piece of mechanism for promoting diffusion.

In the first place it is found experimentally that the most economical arrangement of very small apertures is to have them set about 8 or 10 diameters apart, for at that distance the interference with each other practically ceases. *This is about the distance at which we generally find the stomates arranged on the underside of most leaves.*

You will remember that the amount of atmospheric carbonic acid which enters an assimilating leaf in an hour is about ·1 c.c. for every square centimetre of leaf. Now it can be shown tha for this amount of gas to enter through the stomates it is only necessary for the CO_2 content of the air just within the leaf to be kept down to 2·8 parts per 10,000, when that of the outer air is 3 parts per 10,000. This very slight difference in the partial pressure within and without is quite sufficient to account for all the entering CO_2, thanks to the special structure of the leaf.

Thus all the apparent difficulties in the way of accepting the

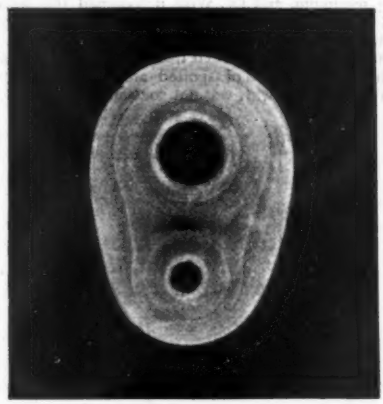


FIG. 9.

minute stomates as the sole pathways of gaseous exchange in the leaf entirely disappear when the leaf is studied in this new light, and it becomes evident that the adjustment of the mechanism of the leaf to the physical properties of its surrounding medium is far more perfect than has been hitherto suspected. The leaves of plants have, in fact, proved to be better physicists

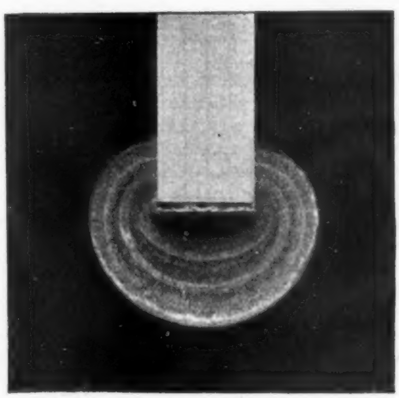


FIG. 11.

than we are, since their structure bears the impress of response to certain properties of gases of which we have hitherto been ignorant.

This is by no means the first occasion on which the plant has given us a lead in physics. The theory of dilute solutions, formulated by van 't Hoff, and indicating that the laws of Boyle and of Avogadro are as applicable to dilute solutions as they are to gases, had its origin in the observations of De Vries and of Pfeffer on the plasmolysis of living cells and the properties of natural semi-permeable membranes.

Nor can we doubt that there are many more such instances which only await detection, and we may reasonably hope that the boundaries of physics and of chemistry will be materially enlarged in unexpected directions if we pay due regard to the whispered hints and slender clues which are on all sides given by the living world of Nature.

A LONG PERIOD SUNSPOT VARIATION.[1]

IT has long been known, and Dr. Rudolf Wolf of Zurich was the first to draw attention to it, that the length of a sunspot period is only in the *mean* eleven years, and that the real length of any one period might differ from this value by as much as ± two years. Another fact of observation is that the times of maxima do not occur a constant number of years after a preceding minimum, and Dr. Wolf determined the *mean* interval as 4·5 years. The minimum also follows the maximum in a *mean* interval of 6·5 years.

It has further been noticed that the intensity of each period, *i.e.* the total amount of spotted area included between one minim um and the next, was not constant. Dr. Wolf held that these quantities indicated a certain periodicity, and at first suggested a period of 178 years, and later 55·5 years, or a period extending over five eleven-year periods (11·1 × 5 = 55·5).

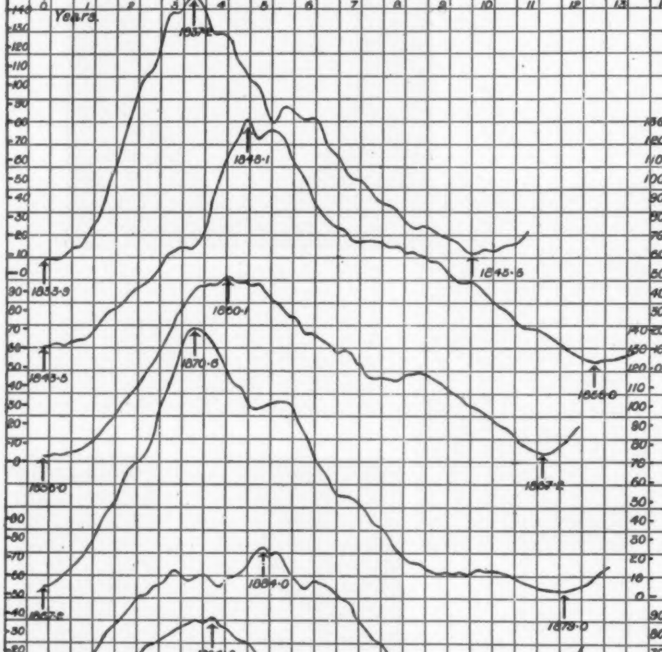


FIG. 1.

The present investigation was limited to the interval of time, namely, 1833–1900, over which *systematic* observations of the sun's surface have been regularly made, and as Dr. Wolf's relative numbers agree well with the actual facts of observation over this period, these numbers have been employed.

The important magnetic results obtained by Mr. William Ellis served as a check on the whole work, since he has shown that the curves for the magnetic elements are in almost exact accord with those of the sunspots. Any variations determined from the sunspot curves should, then, have their counterpart in the magnetic curves.

Fig. 1 will give the reader an idea of each sunspot curve from minimum to minimum for the period above mentioned.

They are so arranged in order of date that each individual curve can be examined separately. The times of succeeding minima are arranged vertically under each other, so that any variation as regards acceleration or retardation of the following maxima, and any inequality in the length of the period minimum to minimum can be seen at a glance; each of these epochs is indicated in the figure by a short arrow with the corresponding dates.

Dealing with the inequalities of the interval minimum to maximum, it is found that there is a regular variation having a period of about thirty-five years. Curve B, Fig. 2, shows this variation, the abscissæ representing the time element and the ordinates the intervals minimum to maximum plotted at the epochs of the minima.

Dealing with the intervals minimum to maximum of the magnetic curves in a similar way, the result obtained is shown in the same figure, curve C.

Both these curves thus indicate that there is some law at work which introduces a secular variation by retarding periodically the sunspot maxima in relation to the preceding minima. The actual epoch of maximum relative to the preceding minimum oscillates about the mean value 4·12 years, its greatest amplitude being in the mean about 0·8 year.

Another point of great importance is that when the epoch of maximum spotted area follows in the shortest interval of time after a minimum, the spotted area for the whole period is greater than at any other time.

Thus, if the spotted area included between consecutive minima be summed up for each period, and these values, used as ordinates, be plotted at the epochs of minima, as done previously, and the curve inverted, curve D Fig. 2 is the result. It will be noticed that this curve is very similar to the two immediately above it, and shows a period of about the same length, namely, about thirty-five years. It may be here remarked that the value for the total spotted area for the period 1833·9 to 1843·5, the earliest value in point of time dealt with, is not quite in harmony with the other values. There seems, however, sufficient evidence to indicate that the small value may be due to the fact that the observations were not then made quite on a uniform plan. That the maximum of 1836 was a great one, and only equalled by that of 1870, is well known.

The discussion of these observations thus leads to the important conclusion that *underlying the ordinary sunspot period of about eleven years there is another cycle of greater length, namely, about thirty-five years.*

This cycle not only alters the time of occurrence of the maxima in relation to the preceding minima, but causes changes in the total spotted area of the sun from one eleven-year period to another.

A glance at Fig. 1 will show that the length of the period minimum to minimum seems to alternate, the magnitude of these alternations becoming smaller. An attempt was made to see if any law could be traced, but although there was a variation suspected in the length of both the magnetic and sunspot periods (reckoning from minimum to minimum), which increases and decreases in *alternate* eleven-year periods from a mean value, the observations do not extend over a sufficient interval of time to allow a more definite conclusion to be drawn.

It is generally conceded that the spots on the surface of the sun are the result of greater activity in the circulation in the solar atmosphere, and therefore indicate greater heat and, therefore, light. This being so, the curve representing the spotted area may be regarded as a light curve of the sun.

[1] Abstract of a paper, "The Solar Activity 1833–1900," read before the Royal Society on May 23, by Dr. William J. S. Lockyer.

The sun may thus be considered a variable star (1) the light of which (reckoning from minimum to minimum) is variable, with a mean value of about 11·1 years; (2) the epoch of maximum does not occur a constant number of years after the preceding minimum, but varies regularly, the cycle of variations covering about thirty-five years.

It is interesting, therefore, to know that the sun is not the only star which exhibits variations similar in kind to those mentioned above, for the light curve of η Aquilæ not only has a more rapid rise to maximum and slow fall to minimum, but the periods from minimum to minimum vary in length, and the interval minimum to maximum has a regular variation.

Since then, in addition to the well-known eleven-year period of sunspot frequency, there is another cycle which extends over about thirty-five years, and which is indicated clearly, as has been shown, both by the changes in the times of the occurrence of the epochs of maxima and in the variations in area included in consecutive eleven-year periods of both sunspot and magnetic curves, it is only natural to suppose that this long-period variation is the effect of a cycle of disturbances in the sun's atmosphere itself.

Such a cycle, if of sufficient intensity, should cause a variation from the normal circulation of the earth's atmosphere, and should be indicated in all meteorological and like phenomena.

We are indebted to Prof. Ed. Brückner for the great work on the changes in climates, and in this investigation he sought variations in the observations of the height of the waters in inland seas, lakes and rivers; in the observations of rainfall, pressure and temperature; in the movements of glaciers; in the frequency of cold winters; growth of vines, &c.

The result of the whole of the investigation led him to the conclusion that there is a *periodical variation in the climates over the whole earth, the mean length of this period being* $34{\cdot}8 \pm 0{\cdot}7$ *years.*

Prof. Brückner was so convinced of the undoubted climate variations which he deduced, and so certain that such variations could only be caused by an external influence, that he investigated Wolf's sunspot numbers to see whether such a cycle was indicated. Not finding any he was led to make the bold suggestion that such a variation as he sought must really exist in the sun, but might possibly be independent of sunspots. He finally concluded that the climate variations are the first symptom of a long period variation in the sun, which probably will be discovered later.

In the light of the secular period of solar activity dealt with in this article, Prof. Brückner's conclusions are of great interest, because not only does the length of the period, but the critical epochs of his cycle completely harmonise with those found in the present discussion of the sunspot and magnetic curves.

To illustrate more fully this connection and to take only one case, namely, rainfall, three rainfall curves which have been copied from his book are reproduced in Fig. 2 (curves E, F, G).

E and F represent the secular variations for what Prof. Brückner calls "Reguläre Gebiete I and II," while curve E is the mean for the whole set of observations he has employed, and represents the secular variation of rainfall over the whole earth so far as can be determined.

The comparison of these curves with those representing the sunspot and magnetic results given above them shows that when the epoch of maximum spotted area (curve B) follows late after the preceding epoch of minimum (1843, 1878), or when the spotted area from minimum to minimum is least (curve D), the long period rainfall curve is at its maximum or we have a wet cycle. When, on the other hand, the maximum (curve B) follows soon after the preceding minimum (1867), and the spotted area for this cycle is at a maximum (curve D), the rainfall curve is at a minimum or a dry cycle is in progress.

Prof. Ed. Richter, in a detailed investigation of the movement of glaciers, has also found a cycle of thirty-five years, and he pointed out that the variations agreed generally with Brückner's climate variations, the glacier movement being accelerated during the wet and cool periods.

Again, Mr. Charles Egeson not only finds a secular period of about thirty-three to thirty-four years in the occurrence of rainfall, thunderstorms and westerly winds in the month of April

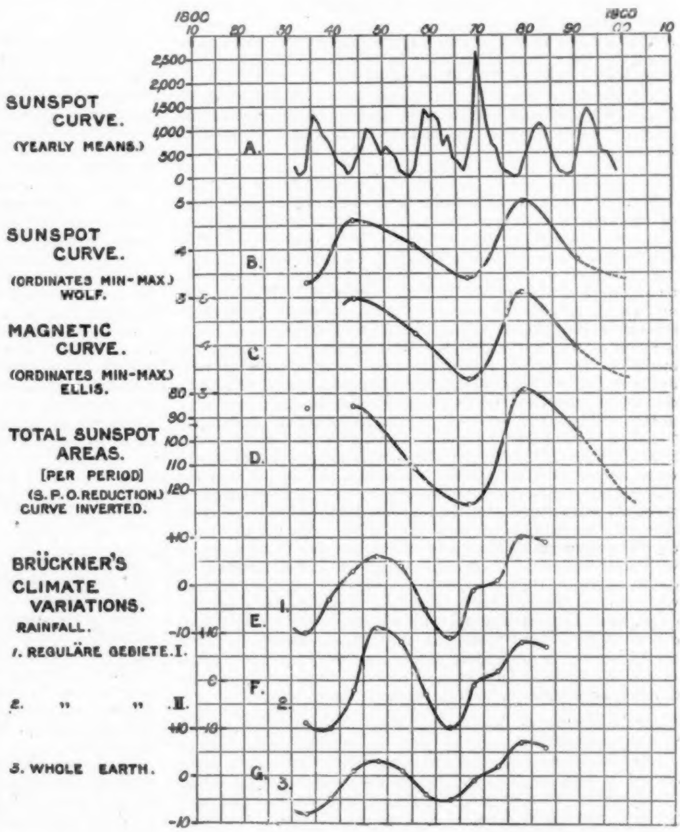


FIG. 2.

for Sydney, but the epochs of maxima of the two latter harmonise with the epochs of the thirty-five yearly period deduced for sunspots.

There seems little doubt that, during the interval of time covered by the present sunspot discussion, the meteorological phenomena, number of auroræ, and magnetic storms show secular variations of a period of about thirty-five years, the epochs of which harmonise with those of the secular variations of sunspots. As we are now beginning to approach another maximum of sunspots which should correspond both in intensity and in time of occurrence after the epoch of the present minimum with that of 1870·8, it will be interesting to observe whether all the solar, meteorological and magnetical phenomena of that period will be repeated.

WILLIAM J. S. LOCKYER.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—At a convocation on June 18, the honorary degree of D.C.L. was conferred upon Mr. Cornelius N. Dalton, C.B., master of the Drapers' Company.

On the same day, the new Radcliffe Library building, which has been erected by the Drapers' Company at a cost of about 21,000*l.*, was formally handed over to the University in the presence of a large number of members of the Company and of the University.

CAMBRIDGE.—Prof. Newton, F.R.S., has been appointed a manager of the Balfour fund for the ensuing five years.

The Harkness scholarship in geology has been awarded to W. G. Fearnsides, Sidney, and the Wiltshire prize in palæontology to E. R. Watson, Jesus.

Thirty-seven names appear in the first class of the natural sciences tripos, part i., and ten in the first class of part ii. Four are the names of Newnham students.

The work of Mr. Hugh Ramage, advanced student of St. John's, on spectrum analysis, has been pronounced "of distinction" as a record of original research and as a qualification for the B.A. degree.

MR. CHAMBERLAIN has addressed a letter to the Lord Mayor of Birmingham, on behalf of the council of the Birmingham University, suggesting that a rate should be made in aid of the University. The amount subscribed for the establishment of the University is 400,000*l.*, but a large proportion of this will be absorbed in the erection and equipment of buildings necessary for instruction and research. The increased cost of maintenance involved in the scheme cannot be wholly provided from the fees of students, and it is on this account that an appeal is made for assistance. In support of the appeal the council refer to the precedents already established in similar cases, notably in connection with University colleges founded in other provincial towns. Thus the corporation of Nottingham contributes 7380*l.* a year to Nottingham College, Sheffield gives nearly 6000*l.* a year to the Firth College, the corporation of Leeds 1500*l.* a year, the corporation of Manchester 1100*l.*, and the corporation of Liverpool, besides a grant of land of the value of 30,000*l.*, an annual contribution of 1800*l.* Other contributions of a substantial character have been made in many cases by the county authorities; and it is hoped that if Birmingham will set the example the counties which will derive benefit from the extension now proposed of University work in the Midlands will not be unwilling to take their share of responsibility. A rate of ½d. in the pound would in Birmingham provide an annual contribution of about 5000*l.*, which would justify the council of the University in proceeding immediately with the new departments, the necessity for which, in view of the increasing pressure of foreign competition, is daily becoming more urgent.

AT the meeting of the General Medical Council last week a prolonged discussion occurred upon the regulations for the first year of medical study, and the educational institutions which should be accepted as fit and proper places for passing one year of the obligatory five years of professional study. The main question was whether a year at a grammar school, or similar educational establishment where general subjects as well as science is taught, should count as one year of medical training in the five years' curriculum. For one side it was stated that the laboratories at some of the institutions recognised by the Council were as well equipped as those of some medical schools. It was also urged that chemistry, physics and biology might be considered as an extension of the preliminary education required before medical study, properly so called, can be commenced, and that the medical curriculum required should be four years taken subsequently to passing an examination in them. If this view is accepted at the next meeting of the Council, it would seem, says the *British Medical Journal*, that the whole question of the places at which instruction may be obtained may disappear, for it will be argued that, provided the necessary knowledge is obtained and tested by adequate examination, it will no longer be the business of the Council to concern itself how or where it is obtained, any more than in the case of Latin or any other subject of preliminary education. The subject has been referred to the Education Committee of the Council, and judging from the views expressed during the debate it seems that there are not a few members who think that scientific education is now provided for so well at schools not strictly medical that one year of professional study may properly be carried out in such institutions.

SCIENTIFIC SERIAL.

Bulletin of the American Mathematical Society, May.—The three papers in the present number were all read at the February meeting of the Society. Non-oscillatory linear differential equations of the second order, by Prof. Bôcher, has for its object the deduction of certain conditions that the equation

$$\frac{d^2y}{dx^2} + \frac{pdy}{dx} + qy = 0$$

should be non-oscillatory. This equation is said to be oscillatory or non-oscillatory in the interval $a \leqq x \leqq b$, according as it does or does not have at least one solution (not identically zero) which vanishes more than once in this interval. Conditions have been obtained by Picard, but the method used in the present paper is not only entirely different, but yields, in addition, other results not given by Picard's method. In the author's opinion it is also less artificial.—Concerning real and complex continuous groups, by Prof. L. E. Dickson, is an attempt to illustrate certain differences and analogies between related real and complex continuous groups. Lie's theory has been developed chiefly for the latter groups, the modifications necessary for real groups being treated quite briefly.—On holomorphisms and primitive roots, by Dr. G. A. Miller, is devoted to some additional developments along the earlier line adopted by the author in a previous paper (*Bulletin*, vol. vi. p. 337, 1900).—The following works are reviewed, viz.: "Einleitung in die Theorie der Besselschen Funktionen" (Prof. J. H. Graf and Dr. E. Gubler), by Dr. V. Snyder; and "Leçons sur la théorie des Formes et la Géométrie analytique supérieure" (H. Andoyer), by H. S. White.—The usual points of interest, collegiate and other announcements, and list of recent publications are well to the front.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 23.—"On the Presence of a Glycolytic Enzyme in Muscle." By Sir Lauder Brunton, F.R.S., and Herbert Rhodes.

For some time physiologists have suspected the presence of some enzyme in muscle which has the power of breaking up the sugar with which the muscle is supplied through the blood, and converting this food into energy with the formation of simpler oxidised bodies. The presence of such an enzyme in fresh muscle juice was apparently proved by Brunton in 1873, but the method of experiment used was open to criticism.

Previous to the present paper the materials used had not been rendered free from possible fermentative organisms, so that it could not be definitely said that the marked glycolytic action exhibited by the juice was not due to some fermenting fungus or bacterial contamination.

The muscle juice was obtained from the yet living flesh of a sheep by comminution with sand and hydraulic expression.

In these later experiments the muscle juice was rendered sterile by filtration through a Pasteur Chamberland candle, the other fluids boiled for considerable periods, and the apparatus disinfected by steam.

Two flasks were prepared, each containing fresh sterile muscle juice and sugar solution; in one the juice was boiled previously to adding the sugar solution.

After incubation at body temperature the sugar in each flask was estimated quantitatively, the result showing a very marked diminution in the percentage of sugar in the flask containing unboiled juice.

Thus it was shown that a substance exists in fresh muscle which has the power of breaking up the sugar molecule, and this substance partakes of the nature of a glycolytic enzyme.

Although an attempt had been made to isolate the enzyme, it is of such a delicate nature that the isolating procedure adopted destroyed its fermenting power.

Physical Society, June 14.—Prof. S. P. Thompson, F.R.S., president, in the chair.—A paper on Herr Jahn's measurements of the electromotive force of concentration cells was read by Dr. Lehfeldt. Prof. D. Jahn has recently published measurements of E.M.F.'s of concentration cells, from which he has endeavoured to show that the law of dilution is applicable to strong solutions. The author points out that his conclusions are based on argument in a circle because Ostwald's law is assumed in the formula used by Jahn for calculating degrees of concentration. The formulæ of Nernst and Arrhenius do not yield consistent results, and it is suggested that the former is suitable for calculating concentrations and the latter for calculating osmotic pressures.—A paper on the mechanism of radiation was read by Mr. J. H. Jeans. This paper contains an attempt to obtain answers to two questions:—(1) What inferences can be drawn as to the mechanism by which radiation is emitted from an examination of the formula of physical optics? and (2) Is it possible, with the help of these inferences, to frame any conception of matter which will give a consistent account of the various optical phenomena? Starting with general spectroscopy, the author has written down the radiation due to a single rotating molecule vibrating harmonically. The effect of a number of molecules is deduced, and it is shown that the condition that the continuous banded spectrum shall be absent is that either the period of rotation must be large compared with the period of vibration or the radiation from a molecule must be spherically symmetrical. Passing on to dispersion, even if the radiation is continuous between collisions, there will be a discontinuity at every collision and the train of waves will be no longer regular. It is customary to assume that the vibrations of a dispersing medium are sympathetic with the irregular incident light. The author has calculated the ratio between forced and free vibrations in a prism or grating, and finds that if the dispersion is to be regular the vibrations must be only slightly influenced by collisions, and this requires, as in the former case, that either the period of rotation is large compared with the period of vibration, or the radiation is spherically symmetrical. As this is not the case with molecules the author thinks that the line spectrum is emitted by atoms, that these atoms must be dissociated and that the shape of these atoms is one of spherical symmetry. It is shown that if an atom is an electromagnetic system, similar to a planetary system, then the periods of such an atom would not be fixed and there would be no reason for a line spectrum. The normal atom is therefore regarded as an electrostatic system, with some law of force, other than the inverse square law, holding at interionic distances. Such an atom when at rest would give a pure line spectrum. Rotation of such an atom causes the lines of the spectrum to shift towards the red, and as the rotation is different for different atoms the lines will not only be shifted, but broadened. To calculate the periods of vibration of an atom the author has assumed it to consist of an infinitely great number of infinitely small ions. The spectrum of this consists of a collection of spectrum series each possessing a definite head and capable of explaining doublets, triplets, &c. It is shown that under the action of a magnetic field a line may separate out into approximately equidistant lines, the central lines maintaining its position. In conclusion, the author points to many other physical phenomena which can be explained by the theory described.—The chairman then exhibited some specimens of Jena glass. In describing these, reference was made to a diagram showing the refractive index, dispersion between the C and F lines, and the reciprocal of the dispersive power of any piece of glass. For this latter quantity the symbol "ν" is used, and it was suggested to call it the achromatic refractivity of the glass. The introduction of barium increases the deviation, but leaves the dispersion unaltered. It is possible now to get crown glass with a higher refractive index than flint glass, and this makes it possible to construct an achromatic lens which will also give a flat field. It is usual in making achromatic objectives to make them accurately achromatic for the red and violet rays. A better effect can be obtained by having approximate achromatism throughout the length of the spectrum. This is achieved by matching the irrationality of one glass by means of another and then constructing an achromatic pair with these two glasses. "Telescope crown" and "telescope flint" are two glasses which give similar spectra and approximate achromatism from the red to the violet.—The Society then adjourned until June 28, when the meeting will be held, by the invitation of Prof. W. G. Adams, in the laboratory of King's College.

Geological Society, June 5.—Mr. J. J. H. Teall, V.P.R.S., president, in the chair.—On the passage of a seam of coal into a seam of dolomite, by Aubrey Strahan. The author was informed by Mr. N. R. Griffith in 1900 that the seven-feet seam of the Wirral Colliery had been found to pass into stone of an unusual character. For a distance of 1600 yards from the shaft this seam was good, and about 4 feet thick. A little farther in bands of stone from 1 to 10 inches thick made their appearance in it, and, gradually increasing in thickness, these bands eventually constituted the whole seam, the last traces of workable coal disappearing at 250 yards from the point where the change first began. The boundary of the barren area has been found for a distance of 1480 yards, and it runs north and south. The stone is at first black, but after weathering it becomes grey, and displays curious structures, among which are pisolitic, or mammillated structures, the intervening spaces being filled with coaly matter. One specimen displays woody tissue filled with dolomite. Analyses by Dr. W. Pollard yield from 18·5 to 13 per cent. of magnesia. The phenomena are not those of a "washout," as there is no sign of erosion, but there is proof that the dolomite was formed in almost motionless water, and the conditions appear to have been those under which a tufa would form. It appears to have been formed on a spot to which clastic material scarcely gained access, and which was reached even by vegetable matter in scant quantity and in a finely divided condition.—On some landslips in boulder-clay near Scarborough, by Horace W. Monckton.

EDINBURGH.

Royal Society, June 3.—Dr. Hepburn in the chair.—In a paper on binary fission in the life-history of Ciliata, Dr. J. Y. Simpson gave excerpts from statistics of two months' cultures of *Paramoecium caudatum* showing that under the most natural circumstances attainable binary fission does not proceed with that mechanical regularity that Maupas asserted. Further, experimenting with cultures of *Stylossichia pustulata*, he found with Joukowsky as against Maupas that degeneration after continued division shows itself in a general listlessness, in ebbing of vital energy and decrease of size, rather than in definite nuclear disorganisation, but on the other hand, with Maupas as against Joukowsky, that it is not possible to induce conjugation before puberty. Some Paramœcium monstrosities were described, and microphotographs of living *P. aurelia* and *P. caudatum* were shown, establishing the existence of the two species which had recently been called in question.—Dr. E. G. Coker communicated a paper in which were described his various forms of apparatus for measuring strain and applying stress, together with a great many measurements made by means of them. The aim in all was to have the different parts of the measuring apparatus attached to the specimen itself; and probably the most ingenious arrangement was the device for applying and measuring the effects of combined bending and twisting. Another combination was longitudinal stretch and twist. The influence of the one kind of strain upon the elastic relations of the other kind were carefully investigated, especially in the neighbourhood of the yield-point. The behaviour of iron and steel bars when subjected to strain cycles was also studied, and other important questions connected with hysteresis, fatigue and recovery in time.—Mr. W. E. Collinge communicated a paper on the anatomy of a collection of slugs from North-west Borneo, the general results being as follows. The *Damayantia plecta* of Issel was re-described and some notes given on the anatomy of the new species, *D. carinata*. Two new genera were established, viz., Wiegmannia and Isselentia, with five new species. The *Damayantia smithi* (Cllge. and Godw., Auct.) was shown on anatomical grounds to belong to the genus Collingia. Finally two new species of Veronicella and one of Onchidium were described, and a check list of the known species from Borneo was given.

PARIS.

Academy of Sciences, June 10.—M. Fouqué in the chair.—Studies in neutralisation. On the titration of acids and alkalis of complex function with the aid of colouring matters, by M. Berthelot. A study of the behaviour of some amino-acids towards indicators. Of these glycocoll and leucine are acid to phenolphthalein, alkaline to methyl-orange, and neutral to litmus. The three aminobenzoic acids have a clearly acid function except towards methyl-orange.—The phenomena of

calorific convection and the cooling power of liquids, by M. J. Boussinesq.—On the series of Bernoulli, by M. G. Mittag-Leffler.—On the Eulerian incomplete integrals of the second species and the indefinite integrals of the preceding functions, by M. E. Vallier.—On the region of convergence of an infinite integral, by M. E. Phragmén.—On a remarkable invariant of certain transformations realised by self-recording apparatus, by M. Rabut.—The laws of Gay-Lussac and the dissociation of gaseous compounds, by M. A. Ponsot. It is usually held that the law of Avogadro is an approximate law which tends to become more exact as the volume increases. According to the investigation in the present paper this is not the case.—The vibrations produced in a wire with an influence machine, by M. D. Negreano. If an insulated stretched wire contained in a tube is connected with one of the poles of a Wimshurst influence machine, transverse vibrations are set up in the wire, and if viewed in the dark, portions of the wire become visible.—On an electrolytic rectifier, by M. Ch. Pollak. A description of the conditions under which it is possible to use aluminium electrodes in an electrolytic apparatus for rectifying alternating currents, together with the precautions necessary in forming the plates.—On an electrical grisoumeter, by M. G. Léon. Two small platinum wires forming two of the arms of a Wheatstone's bridge are kept at a red heat by a small battery of accumulators, one of the wires being placed in pure air and the other in the atmosphere containing methane. The presence of the methane causes a rise in the temperature of the latter wire which results in a deflection of the galvanometer, this deflection being proportional to the amount of marsh gas present.—On the experimental verification of a law of chemical mechanics, by M. H. Pélabon. The reaction between hydrogen and mercuric sulphide has been experimentally studied and the results applied to the verification of the formula $p_1p_2/p_3p_4=f(T)$.—The action of a metallic hydrate upon a salt of another metal. Basic salts with two metals, by M. A. Recoura. Results of experiments upon the reactions between copper hydrate upon solutions of zinc sulphate, and of the sulphates of cadmium, manganese, cobalt, nickel and copper.—On the imidodithiocarbonic esters, $RN:C(SR')_2$, by M. Marcel Delépine.—On the active erythritols, by MM. L. Maquenne and G. Bertrand. Measurements of the rotatory power of the two erythritols in water and in alcohol, and description of the preparation of the tetra-acetyl, benzoyl and valeryl derivatives, and also of the oxidation products.—Study of a densimeter for the determination of the baking value of wheaten flour, by M. E. Fleurent.—Analysis of some travertines from the Vichy basin, by MM. C. Girard and F. Bordas.—On the olivine gabbro from Kosswinsky-Kamen (Ural), by MM. L. Duparc and F. Pearce.—On the function of the eustatic oscillations of the level of the base in the formation of systems of terraces in some valleys, by M. D. Lamothe.—On the morphology of the sexual elements in some species of Stylorhynchus by M. Louis Léger.—On the constant presence of a gregariniform stage in the cycle of evolution of hematozoa of malaria, by M. A. Billet.—New observations on the parthenogenesis of the sea urchin, by M. G. Viguier.—On the use of silicotungstic acid as a reagent for the alkaloids of urine. The variations of alkaloidal nitrogen, by M. H. Guillemard. The ratio of the alkaloidal nitrogen to the total nitrogen existing in urine varies to some extent with the food, but in certain febrile diseases this ratio undergoes enormous variations, there being in the latter case a considerable increase in both the absolute and relative quantities of the alkaloids eliminated.—On the otoliths of the frog, by M. Marage.—On a new method of examination for the typhoid bacillus, by M. R. Cambier. It is found that if a sterile broth contained in a tube of biscuit porcelain, which latter dips also into sterile broth, is inoculated with the typhoid bacillus, in the course of its growth the bacillus is able to make its way through the porcelain, even although this same porcelain is quite capable of filtering off the bacillus in the ordinary way. It was found that the more actively motile the bacillus the more easily was the filter penetrated in this way. Several other species of bacilli were found to be capable of traversing the walls of the filter in a similar way, but none of the species examined up to the present pass through so rapidly as the typhoid bacillus. On the basis of these observations the author founds a method of determining the presence of this bacillus in potable water, and he has been able to recognise the Ebert bacillus in water from the Seine and the Marne and also in the waters from certain springs.—Six months' meteorological observations at Quito, by M. F. Gonnessiat.

DIARY OF SOCIETIES.

THURSDAY, JUNE 20.

ROYAL SOCIETY, at 4.30.—The Nature and Origin of the Poison of *Lotus arabicus*: W. R. Dunstan, F.R.S., and T. A. Henry.—(1) On the Mathematical Theory of Errors of Judgment, with Special Reference to the Personal Equation; (2) Mathematical Contributions to the Theory of Evolution. X. Supplement to a Memoir on Skew Variation: Prof. K. Pearson, F.R.S.—On the Application of Maxwell's Curves to Three-Colour Work, with Especial Reference to the Nature of the Inks to be employed, and to the Determination of the Suitable Light-filters: Dr. R. S. Clay.—On the Structure and Affinities of *Dipteris*, with Notes on the Geological History of the Dipteridinæ: A. C. Seward, F.R.S., and Miss E. Dale.—(1) Further Observations on Nova Persei, No. 3; (2) Total Eclipse of the Sun, May 28, 1900: Account of the Observations made by the Solar Physics Observatory Eclipse Expedition and the Officers and Men of H.M.S. *Theseus*, at Santa Pola, Spain: Sir Norman Lockyer, K.C.B., F.R.S.—The Mechanism of the Electric Arc: Mrs. H. Ayrton.—And other Papers.

LINNEAN SOCIETY, at 8.—On the Freshwater Algæ of Ceylon: W. West and G. S. West.—On Coprophilous Fungi: George Massee and E. Salmon.—Revision of the Genus Hypericophyllum, Steetz, with Notes on certain Genera with which it has been confused: N. E. Brown.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—The Direct Union of Carbon and Hydrogen, Part II.: W. A. Bone and D. S. Jerdan.—Ammonium and other Imidosulphites: E. Divers and M. Ogawa.—Nitrilosulphates: E. Divers and T. Haga.—The Decomposition of Hydrocarbons at High Temperatures: W. A. Bone and D. S. Jerdan.—The Sugars from Cellulose: H. J. H. Fenton.—On a Theory of Chemical Combination: G. Martin.—On the Occurrence of Paraffins in the Leaf of Tobacco: Dr. T. E. Thorpe, C.B., F.R.S., and John Holmes.—Studies in the Camphane Series, Part IV.: M. O. Forster.—On the Decomposition of Carbon Dioxide, when submitted to Electric Discharge at Low Pressures: Dr. J. N. Collie, F.R.S.—Two New Substances in Lemon Oil: H. E. Burgess.

MONDAY, JUNE 24.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Belgian Antarctic Expedition: Henryk Arctowski.

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